POWER

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Coal a Public Utility

THE newspapers announce the determination of the Administration to keep hands off in the hold-up to which the people are being subjected in the matter of their coal supply.

A large section of the population is shut off from its accustomed supply of fuel. For such anthracite as is available and for substitute fuels, greatly enhanced prices are being charged.

It costs no more to mine and haul bituminous coal than ordinarily—but what you have to pay for it!

The President says that there is no authority for government interference until an actual emergency exists.

Does this mean that the people must tamely submit to being periodically mulcted in the enjoyment of one of their principal natural resources and that there is no method by which they can, in a lawful and orderly manner, act in their organized collective capacity (that is, through their government) to prevent it?

The average citizen wants to see the men who mine his coal receive wages commensurate with the work that they do and the risks that they take, wages that will let them live up to the American standard, bring up their families with modern advantages and in healthful, agreeable surroundings. He is willing to pay enough for his coal to allow this, and in the final analysis it is he and not the mine operator who pays the miner's wages.

He is willing to pay the mine owner and operator a fair return on the money actually and necessarily invested in mining his coal for him, and a generous compensation for his own executive labor, if he does any.

He expects to pay the costs of hauling and handling and the necessary costs and profits of merchandising.

There ought to be some way of finding out whether he is paying more or less than this. He cannot find this out individually, or if he did, could individually do nothing about it.

The mining and distribution of coal is charged with public interest. It is as much a public utility as transportation, communication, or the supply of water, gas and electricity.

Some Administration will endear itself to the people by finding this out and doing something about it.

F. R. Low

A. S. M. E. Annual Meeting

A WELL-BALANCED program for the technical sessions, particularly with reference to the power field, addresses by two Cabinet officers, as well as by two outstanding scientists, and an attractive social program marked the Forty-sixth annual meeting of the American Society of Mechanical Engineers, held at the Engineering Societies Building, New York, Nov. 30 to Dec. 4.

Of particular interest were the papers dealing with power in the industrial plant, that by W. F. Ryan on "The Value of Higher Steam Pressures" being representative of a marked tendency in that field. Other papers in this class were the "Supply of Industrial Power," by W. H. Larkin, and "Power for Textile Mills," by Charles T. Main.

The Henry R. Towne lecture, established by the Society, for the presentation of the newest thought on topics in the zone between engineering and economics, was delivered by Secretary Hoover, who chose as his subject, "The Economic Value of Research in Pure Science."

The Robert Henry Thurston lecture, established in honor of the first president of the Society, was delivered by Dr. Zay Jeffries, of the Aluminum Company of America, who talked on "Engineering and Science in the Metal Industry."

Following the presidential address on Tuesday evening, honorary memberships were conferred upon Worcester R. Warner and Herbert C. Hoover.

Engineer's Opportunity Stressed in Presidential Address

Speaking to the subject "The Engineer and Civilization," Dr. W. F. Durand, in his presidential address, showed how the evolution of civilization has been largely dependent on three factors—specialization, co-operation and the utilization of natural resources. In each of these the engineer has performed an important service, not only in the rôle that he now occupies, but in the guise of a specialized artisan through past ages.

In solving problems, the engineer follows logical processes of evaluating factors, with discrimination between known data and acts of judgment. His method of approach might well be applied to the study of other factors in life. This does not mean that he can pose as an expert in these various fields, but rather, he is qualified to serve effectively with others who may be able to supply the more narrow technical details in the study of a wide variety of problems.

Collectively, engineers, through their societies have far-reaching opportunities in the opinion of Doctor Durand. In this connection, he said:

"The engineering societies, collectively and individually will best serve the public welfare and best contribute to the progress of civilization, by developing each in its own sphere, to the highest possible degree. The picture of one great engineering society embracing all who may call themselves engineers and covering the whole field of engineering activity and service, is indeed a beautiful ideal. It seems hardly practicable, however, having in view the great diversity of interest and character of work and the limitations of the individual. If co-operation is necessary between individuals in order to achieve larger ends, so also is it necessary between societies. There are many problems of wide sweep, for the solution of which the world is looking to the engineer, or to the engineer in alliance with his brother, the scientist, and which touch simultaneously the fields of activity of several of our modern engineering societies. These cannot be adequately and properly studied by any one body or group alone.

"Are we, both as individuals and societies, too prone to the microscopic view rather than the telescopic?

"Are we so occupied with the immediate task, that we are in danger of failing to appreciate the articulation of our own task with that of our fellows, or to give thought as to how his task and ours may best fit into the great problems which the progress of our civilization presents?

"Are we, both as individuals and as societies, striving to definitely direct our course with definite objectives in view, with a long look ahead, with a generous recognition of our duty to the generations coming after and with an appreciation of the larger duties of life as members of a great social organism? Or, are we looking only at our immediate environment with its professional problems, and allowing ourselves, with reference to the larger aspects of life, to drift, subject to currents and tides of which we take little or no heed?

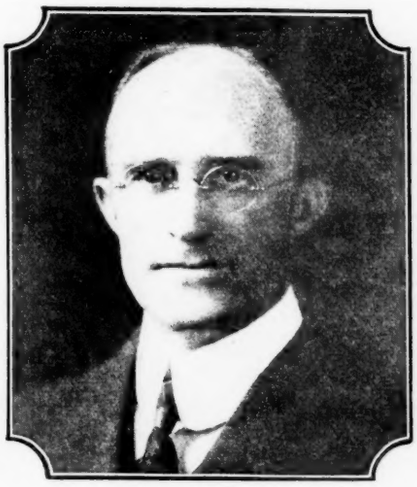
"Among the many problems which thus challenge our attention, none is perhaps of greater importance than that aspect of the duty of the engineer which centers around the general term 'conservation of natural resources.' We have no assurance of the operation of natural agencies, tending toward replacement, at least in any degree commensurate with the rate of exploitation and exhaustion. Future generations may grow beyond the need of some of the things which we now find necessary. Substitutes may be found in some cases, but we cannot be sure of this, and it devolves upon the engineer that he give heed to the means that he employs in the exploitation of these natural resources, and that every possible effort be made to avoid waste and to use the resources with the highest attainable degree of economy and efficiency. We are not to infer that the sole responsibility in these matters lies with the engineer. He may fairly share in with society as a whole; but after all his is, perhaps, the major share because no one is so well qualified as he to see the consequences of the reckless exploitation of nature, and upon no one does the duty lie so clearly to lift up his voice in protest and to direct his professional energies and skill along lines looking toward the reduction of waste and inefficiency.

"It will probably not be claimed that, either as individuals or as societies we have shown the interest in engineering education which its importance requires. The technical schools and colleges are intended to furnish opportunity for the effective training of those of our youth who are to furnish at least a very considerable quota of the new recruits in our ranks. Other things equal, we are more likely to find the leaders of future years among those who have been so trained.

"I admit the inadequacy in some respects, of the

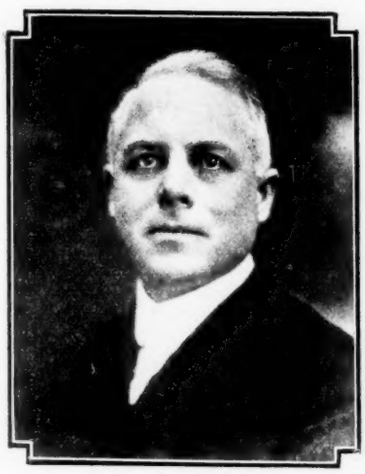
A.S.M.E. Officers for Coming Year

Charles E. Gorton
Manager



Calvin W. Rice
Secretary

Prof. A. G. Christie
Vice-President



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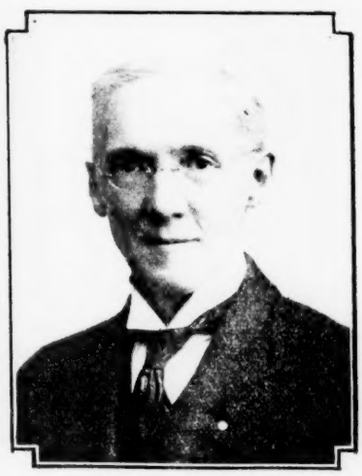
President



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Erik Oberg
Treasurer

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Manager

training which our engineering and technical schools are now giving, due in large degree to the lack of sufficient contact between the schools and the fields of activity in which their educational product is expected to take its place. On the other hand, much of the criticism which has been directed toward the product of our technical schools and colleges has arisen as a result of asking or expecting the wrong things or lack of appreciation of the limitations with which the new recruit must approach his job. These conditions can be vastly ameliorated by a better understanding on both sides. The schools and colleges desire such understanding, and to us, as societies, the duty now comes to arouse a more active interest in this subject and to insure that this training shall be such as best to give a well-rounded development to the mental faculties, stimulate genius and foster those characteristics which make for accurate thinking, independence, originality, devotion to truth, leadership and high character."

Friday evening was given over to a session on National Defense, in which the principal speakers were Secretary of War Davis, Assistant Secretary of War MacNider and General J. G. Harbord; the meeting being presided over by Elbert H. Gary, Chairman of the Advisory Board, New York Ordnance District. The systematic plan for industrial mobilization which has lately been put into effect by the War Department was the topic discussed.

The principal social event of the meeting was the annual dinner on Wednesday evening, at which Dr. Michael I. Pupin, president of the American Institute of Electrical Engineers, was the principal speaker. Samuel H. Libby acted as toastmaster. Dr. Pupin took as his subject "Idealism in Engineering" and brought in some very interesting personal reminiscences.

Steam Tables Research

AT THE steam tables research session on Wednesday afternoon, at which Prof. A. M. Greene, Jr., presided, George A. Orrok, chairman of the research committee on the properties of steam, reported the present status of the work, and detailed reports of experimental progress were presented by Dr. Osborne, of the United States Bureau of Standards, Dr. Keyes and Dr. Smith, of the Massachusetts Institute of Technology, and by Dr. Davis and Dr. Kleinschmidt, of Harvard University.

Some portions of the experimental program have been completed, and for others the apparatus is set up and tested, with some observations already made. The task of making heat measurements accurately is beset with great difficulty, and much time has been spent in the study and elimination of sources of error and the development of means for correcting for unavoidable errors. The work involves the measurement of temperatures with an accuracy to the hundredth, or even the thousandth of one degree Fahrenheit, and the control of heat supplies to water and oil baths to within 0.02 deg., over a range up to 700 deg. F., and along with this the measurement of pressure up to 2,000 lb. per sq.in. and higher with an accuracy of one part in 1,000. The data as obtained are checked against the work of previous investigators, and every effort is being made to maintain consistently the highest degree of accuracy obtainable by the most refined methods now known.

While such refinements may seem absurd to the practical operating engineer, it must be borne in mind that the design of economical steam machinery depends upon precise knowledge of the behavior of steam. Particularly in turbine design is it necessary to know the properties of steam very accurately for the calculation of quantities of work developed in expansions through relatively small pressure ranges. In any case it is good to know that, whatever errors may creep into engineering work, at least the basic information is to be as reliable as scientific skill can make it.

Prof. F. O. Ellenwood, of Cornell University, enthusiastically supported by many of those present, discussed the unsuitability of the names *Total Heat* and *Heat Content* for the quantity which they designate, and suggested that a new name be devised which will not suggest false meanings. It was unanimously voted that a committee be formed to consider this matter and develop a suitable name.

J. H. Keenan, of the General Electric Co., presented the results of his work in tabulating and plotting the preliminary results now available in the form of steam tables and a Mollier diagram. The diagram has been printed by the Society in preliminary form and a complete publication will appear in an early issue of *Mechanical Engineering*. Until final results are ready, these tables and charts should prove of great value to those concerned with the properties of steam at high pressures and temperatures.

Mr. Orrok said that it will probably take three years more to complete the work now planned. Financial support in considerable sums has been provided by manufacturers and users of steam-using equipment. Further contributions are needed, and Mr. Orrok is devoting attention to this aspect of the undertaking, which is a noteworthy enterprise for the advancement of engineering knowledge and practice.

Test Code for Steam Turbines

ON TUESDAY morning there was held a public hearing on the Test Code for Steam Turbines, which has been under preparation by a subcommittee of the Power Test Codes Committee during the last six years. After careful work on the part of the committee the code was issued in galley-proof form nearly two years ago, and copies were sent to over 250 interested people, of whom more than 80 responded with comments and criticisms. These were carefully studied by the committee, and the code was revised accordingly. The revision was published in *Mechanical Engineering* for September, 1925, in preparation for the public hearing.

At the hearing considerable interest was evident and a number of points were discussed, notably the testing of turbines operating on the regenerative and reheating cycles, the measurement of the temperature of superheated steam, and the measurement of exhaust pressure in the case of condensing turbines. In general, no serious objections were raised, and there should be no difficulty in revising the code to the satisfaction of all interested parties. After a careful review of all suggestions by the committee the code will issue as one of the established codes of the Society, and it is hoped that it will soon be available to those who need it. In common with all such codes this one will, of course, be revised from time to time to keep it in step with the development of engineering practice.

Urges Greater Financial Support to Pure Science Research

Secretary Hoover, in Towne Lecture Before American Society of Mechanical Engineers, Deplores Lack of Proper Balance Between Pure Science and Industrial Research

THERE is no body of men more interested in the advancement of pure science than our engineers, for the engineering profession is built upon the application of scientific discovery. And of larger vision, if we would command the advance of our material, and to a considerable degree, of our spiritual life, we must maintain the earnest and organized search for truth.

Research in the biological and physical sciences takes two forms—industrial research (which is the application of science), and research in pure science. Obviously, there must first be a pure science before there can be an application. There is a twilight zone between them, but no scientist has difficulty in finding the borders.

While we have in recent years developed our industrial research upon a scale hitherto unparalleled in history, we have by no means kept pace in the development of research in pure science. We have an increase in some ten years from 100 to over 500 laboratories engaged upon search for application of known scientific fact and law. These results have been magnificent. But all these applied-science laboratories are dependent upon the raw material that flows from the laboratories and men engaged in pure science.

Herbert Hoover
Secretary of Commerce

Not only is our nation today greatly deficient in the number of men and equipment for this patient groping for the sources of fundamental truth and natural law, but the sudden growth of industrial laboratories has in itself endangered pure science research by drafting the personnel of pure science into their ranks—depleting at the same time not only our fundamental research staff, but also our university faculties, and thus to some degree drying the stream of creative men at the source. Thus applied science itself will dry up unless we maintain the sources of pure science. This is no complaint against our great industries and their fine vision of the application of science. It simply means we must strengthen the first line of our offensive. The day is gone by when we can depend much upon consequential discovery or invention being made by the genius in the garret. A host of men, great equipment, long patient scientific experiment to build up the structure of knowledge is today the fundamental source of invention and discovery.

Compared with other expenditures of far less importance to human welfare, the amount of money annually devoted in the United States to the aid of investigators and investigation in pure science is absurdly small. It is less than one-tenth of what we spend on cosmetics. We have indeed some fine foundations for pure scientific research. The Carnegie Institute, the Smithsonian Institution, the Rockefeller Institute, and the many other research activities of much more limited but special endowments, the work of our universities, together with the work of the National Research Council and our government agencies, have shown fine accomplishment in this field. But the whole of the income available from these sources for research in pure science certainly does not exceed $10,000,000 a year.

A special study in an industrial laboratory, resulting in the improvement of some machine or process, is of great value to the world. But the discovery of a law of nature, applicable in thousands of instances and forming a permanent and ever available addition to knowledge, is a far greater advance.

Radio communication would have remained not merely impossible but wholly inconceivable except for the fundamental experiments of Faraday, the mathematical formulation of the wave theory by Maxwell, and the experimenal realization of Maxwell's predictions by Hertz; successive advances in knowledge made without thought of immediate application or financial return.

It is on the men in independent research and in our educational institutions that the great burden of scientific advancement must always rest, and from them that the inspiration of the younger generation of oncoming scientific workers is derived. What we need above all things is the better support of these men. They should not, by the necessities of living and the cost of equipment, be forced into our industrial laboratories. Those men who show an aptitude for research should be less engulfed in teaching.

The universities in which most of them are employed are not to be blamed for this, because they do maintain vital interest in research and they would be glad to devote much larger sums to its support if the pressure of other demands would permit. In seeking assistance elsewhere, the investigator encounters ample good will, but sadly inadequate means. We may make these academic posts so attractive to the student of science that he will seek and occupy them permanently because of the opportunities they afford him to advance knowledge by original research without anxiety for bread and family and equipment. It is true that money cannot buy genius, but many a genius in science has defaulted because he has had to eat.

It is unfortunately true that we can claim no such rank in pure science research as that which we enjoy in the field of industrial research. Instead of leading all other countries in the advancement of fundamental scientific knowledge, the United States occupies a position far in the rear of the majority of European nations.

The difficulty we experience in securing a place in science beside the nations of Europe can hardly be due to a lack of men of innate ability, judging from the leading part already played by the United States in finance, in architecture and in applied science. It results partly from the fact that American civilization is only beginning to emerge from the pioneering stage and partly from the financial and other inducements which so often lead talented men reluctantly to accept well-paid industrial positions instead of poorly paid academic and research posts.

We have prided ourselves on our practicality as a nation. Would it not be a practical thing to do to give adequate organized financial support to pure science? And if by chance we develop a little contribution to abstract learning and knowledge, our nation will be immensely greater for it.

Operating Control and High Pressures Discussed at Industrial Power Session

THE Tuesday afternoon session on Industrial Power featured two outstanding papers. One of these, "The Supply of Industrial Power," by W. H. Larkin, Jr., showed a broad grasp of the industrial power problem from the point of view of the man who must be at the same time an engineer, a business man and an executive. Mr. Larkin has had just that experience as power engineer, General Division, United States Rubber Co. His paper was of particular value for its unbiased comment on the relative advantages of buying or purchasing power under various conditions.

The Supply of Industrial Power

Wm. H. Larkin, Jr.

IN AN early issue of *Power* several pages will be devoted to an abstract of Mr. Larkin's paper. Some of the high spots of particular importance are covered in the following paragraphs.

The examination of an industrial power plant should be based on four principles: Suitability, possibility of future enlargement, proper and economical operation, and finally the availability of correct and continuous operating data and cost figures. If the power requirements are small the modern internal-combustion engine or motor drive by central-station electric power may best meet the needs of the factory. Should the heating load be considerable, the steam engine with available exhaust would probably be more economical. When there is a large demand for process steam, the modern high-back-pressure turbine, or perhaps the bleeder-type turbine, may prove best.

A well-considered power-plant program must contemplate enlargement. Many industrial plants are poorly laid out, being piecemeal growths, and are badly adapted for enlargement. In such cases consolidation and electrification will usually pay.

No power department is well operated that does not produce regular and understandable data on power-operating efficiencies and costs that can be prepared from month to month from records of similar plants. Operators should be made to realize that 60 per cent boiler efficiency is poor and that costs per thousand pounds of steam generated, per engine horsepower, or per kilowatt-hour will be carefully checked by the hand that controls the salary list.

No modern factory can afford to be without the instruments that indicate what is going on in the power plant and that will turn their messages of character of daily operation into the office continuously.

Continuous operating efficiency cannot be obtained from the power plant without some definite system of recording performance and costs. Special tests and reports have their value, but some system of regular reports suitable for comparison month by month is of more value. Such a report should give the ratio between cost of power and pounds or quantity of goods produced. It should contain such units as the cost of steam per thousand pounds, evaporation per pound of fuel, etc. Enough operating data should be recorded so that the report can be checked.

One corporation operating several plants in different parts of the country has used such a system of reports with beneficial results for several years. Few plants are too small for something of the kind.

Where it is possible, valuable comparison can be made between a number of plants in the same system or between the plants operated by the members of some association of plant engineers. Such comparisons tend to increase operating efficiency, as it is often found that what was considered good operation will not bear comparison.

The solution of the problem of most economical power generation must be approached with care, as changes usually mean considerable investment. Op-

erating costs in detail should be available over a long period before extensive changes are contemplated.

Discussion on Mr. Larkin's Paper

Discussing Mr. Larkin's paper from the viewpoint of the central station, N. E. Funk, of the Philadelphia Electric Co., called particular attention to the item of interest. While the interest charge was properly eliminated in considering the advisability of shutting down an existing power plant in favor of purchased power, it was still an integral part of the true cost of power. Moreover, according to Mr. Funk, interest should be computed at the rate which could be earned on new money invested in the manufacturing plant, a rate said to be as high as 20 per cent in many cases. He decried any tendency to decide for or against purchasing power without consideration of all the pertinent facts.

Henry F. Scott, plant engineer of the Dennison Manufacturing Co., spoke of the great responsibility resting on the shoulders of the plant engineer where, as is usual, the management has not the knowledge needed for properly deciding such matters as plant extension versus purchase of power. It was his experience that the process as well as the heating load increased in cold and in windy weather. In many cases, said Mr. Scott, it was wisest to accept something less than the lowest operating cost for the sake of a low investment cost. In his plant a rotary converter had been installed to supply all power in excess of that capable of being generated from the heating and process steam.

In his closure Mr. Larkin said his paper would serve its purpose if it stirred up interest in the elimination of waste in the production of industrial power.

Higher Steam Pressures in Industrial Plants

Wm. F. Ryan

IN SPITE of many facts pointing to the contrary conclusion, the impression has been general that the field of extra-high steam pressures lies in central stations rather than industrial plants. Quite a different viewpoint was ably presented by William F. Ryan, power engineer for the Solvay Process Company (Syracuse, N. Y.) in his paper on "The Value of Higher Steam Pressures in the Industrial Plant."

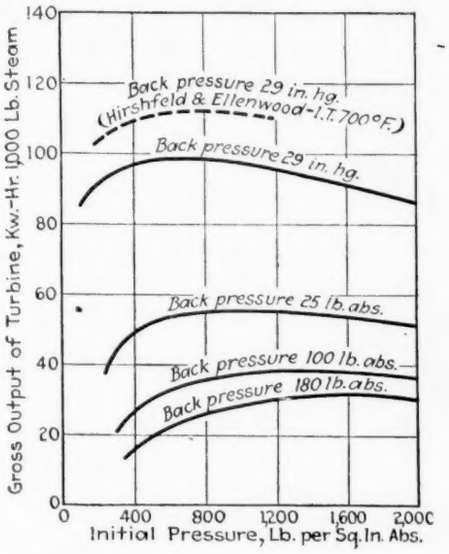
The importance of this paper justifies a more extensive report than is possible in the space here available. An abstract several pages in length will appear in an early issue. Meanwhile the following brief summary will serve to indicate the general drift of Mr. Ryan's arguments:

The value of steam pressures higher than 400 lb. for central stations is still being debated. There can be little question, however, that higher pressures can be used to advantage in industrial plants for which steam is used for manufacturing purposes.

Even where no process steam is used, the condensing-water conditions generally limit the amount of steam that can be condensed with reasonably good vacuum. Higher steam pressures permit more power to be generated without increasing the amount of steam to be condensed.

The economic considerations in applying high steam pressures to the industrial plant are fundamentally different from those of the central station and the problem must be attacked in a different manner.

The important consideration in the industrial plant is not the cyclic efficiency, but the possibility of meeting the power requirement without generating steam beyond that needed for process. The two principal ways of increasing the power obtainable from a given flow of steam exhausted at a given back pressure are to increase the prime-mover efficiency and to run up the initial pressure. A secondary consideration is increased power production by increasing the initial steam temperature. This question is generally bound up with the others by the requirement that the quality or superheat of the exhaust steam must meet the process requirements.



Effect of initial pressure and back pressure on power obtainable from 1,000 lb. of steam per hour

The accompanying curves indicate the effect of increased initial pressures for various back pressures. They show actual power outputs per 1,000 lb. of steam per hour for average turbine units of 1,500 to 5,000-kw. capacity with 725-deg. throttle temperature when operated under the average part-load conditions of the industrial plant. Another set of curves[1] shows the increase in power production possible by running up the steam temperature. For example, at an initial pressure of 565 lb. absolute and 25 lb. absolute back pressure the power output per 1,000 lb. of steam per hour is 40 kw. with steam at 500 deg., 46 kw. at 600 deg., 50 kw. at 700 deg. and 53 kw. at 800 deg.

Where a large amount of equipment (engines, pumps, compressors, etc.) too valuable to be junked is already operating at the present moderate boiler pressure, a high-pressure boiler and prime mover may be added, exhausting to the existing steam main. All additional power generated by such a unit is practically pure gain so far as the coal bill is concerned. Of course, the throttle pressure and temperature of the high-pressure unit must be adjusted to give the required exhaust quality.

[1]See longer abstract to be published later.

Even where the power load can be taken care of by the present initial and process pressures, it may be desirable to increase the initial pressure in order that the process pressure may likewise be increased. Higher process pressures will increase the capacity of present steam-heated equipment or give equal capacity with smaller and cheaper equipment. This applies particularly to process evaporators.

About the only serious problem to be encountered in applying higher pressures to industrial plants is that of suitable feed water.

Where steam is used for direct contact processes, it may be replaced by vapor from single-effect evaporators, the prime-mover exhaust condensing in the evaporator and returning to the boiler as pure distillate.

Discussion Shows Great Interest in Higher Pressures

Extraordinary interest in the subject matter of Mr. Ryan's paper was indicated by a large number of discussions, written and oral. In fact it was finally necessary for Chairman F. R. Low to call off further discussion of this paper because of lack of time.

J. R. McDermet, research engineer of the Elliott Co., was inclined to be skeptical of the general application of extremely high pressures in industrial plants. For one thing he did not see how either lime-soda or zeolite softeners could furnish feed water suitable for such pressures. As if in answer to this objection, a later discussion, by R. E. Hall, of the Bureau of Mines, proposed sodium phosphate as entirely suitable for the treatment of sulphate feed water for high-pressure boilers. Mr. Hall also mentioned the possibility of using sodium phosphate after preliminary treatment with lime and soda.

Mr. McDermet felt that it would not be practicable to use evaporators with more than 25 per cent make up.

Guy B. Randall, chief engineer of the National Cash Register Co.'s power plant, agreed that the industrial plant had more to gain than the central station from high pressures and said that the outlook for cheap power in the industrial plant was better than it had been for years. He was now making a study of a plant where it was planned to increase the steam pressure from 150 to 400 lb. Blowdown losses, according to Mr. Randall are much overestimated. He recommended liberal blowdown and gave instances of resulting large savings due to reduced maintenance expense and coal consumption. Steam, he said, was far superior to electricity as a heating medium for vulcanizing and other medium-temperature ovens, because much more accurate temperature regulation was possible. Where necessary to get high steam pressure, a motor-driven steam booster pump fitted in nicely.

W. G. Diman, chief engineer for the Amoskeag Manufacturing Co. warned against rushing to higher pressures where the necessary power could be generated with but little more steam than that required for process. He felt that in the near future only the exceptional industrial plant could economically employ the higher pressures, and suggested that more attention be given to reducing steam waste in processes.

According to Harold Anderson, of the Westinghouse Electric & Manufacturing Co. (So. Philadelphia), the combination plant obtained by adding high-pressure units exhausting to the present installation promises much for the immediate future. He said manufacturers could supply the demand for suitable high-back-pressure turbines.

One speaker told of a New England plant where 400 lb. is to be used in a new steam turbine bled at 150 lb. to supply steam to old engines and auxiliaries. These, in turn, will run condensing in the summer and exhaust to heating in the winter.

E. D. Dickinson, of the General Electric Co. (Lynn), hoped that more data would be made available regarding the relative efficiencies of turbines and engines under practical operating conditions.

Hans Dahlstrand, of the Allis-Chalmers Co., did not agree that turbine efficiency would necessarily fall off with increasing pressure.

According to Dr. Jacobus, of the Babcock & Wilcox Co., no trouble has been experienced with 600-lb. boilers so far, and little is expected at 1,200 lb. The temperatures involved present no problem, he said.

In his closure Mr. Ryan made a plea for the dissemination of more operating data on important equipment. He made the startling statement that the Syracuse plant of the Solvay Process Co. generates twice as much steam in a year as the Trenton Channel station of The Detroit Edison Co. The yearly power output exceeds 100,000,000 kw.-hr. There had been only one power interruption in forty years. These facts, he said, indicated the importance of the industrial plant and the men who operate it.

Session on Calculation Methods

TWO notable papers were presented at the special Tuesday afternoon session on calculation methods. These were "Graphical Methods of Calculation," by H. L. Seward, and "The Making of Special Slide Rules," by G. W. Greenwood. The nature of these papers was such that brief abstracts would be of little value. Nothing will be attempted here beyond indicating in a general way the field covered.

Professor Seward has been known for years as an authority on graphical computations and is co-author of a standard treatise on the subject. His paper presented at this session might be described as the boiled-down essence of the book and probably contains as much fundamental information on the subject as could be given in the space of fifteen pages. Of the thirty-eight figures used, some were explanatory diagrams and others practical charts for the solution of engineering formulas.

The theory and practice of nomography, as taught by Professor Seward, is built largely around the mathematical device known as a "determinant." Mastery of the principles outlined in the paper should enable one to design a great variety of diagrams for the solution of engineering formulas.

The information contained in Professor Seward's paper is still the property of but a small fraction of the engineering profession. A somewhat larger group would be familiar with the principles outlined by G. W. Greenwood in his paper, "The Making of Special Slide Rules." Mr. Greenwood explained in some detail the general field of usefulness of special slide rules, the types of scales and their particular applications and methods of constructing practicable scales.

Engineers interested in mechanical calculations should obtain the originals of these two papers for study and filing.

Steam Power Session

THE steam power session on Thursday morning drew an audience that filled the auditorium, and great interest was evident throughout the meeting. The chairman was obliged to cut discussion short to avoid interference with later items in the program for the day. The papers and some of the written discussions were presented with the aid of lantern slides, and the material presented constitutes a valuable contribution to the data available to the designer and operator of power-plant equipment. The manner in which the discussers handled the material presented indicates that the subjects considered occupy a large place in present-day engineering thinking.

Recent Developments at Colfax Station

EVER since the completion of the first section of the Colfax Station (Duquesne Light Co., Pittsburgh, Pa.) in the latter part of 1920, engineers have been kept informed of its design, equipment and operating results through A.S.M.E. papers and through articles in the technical press. Several A.S.M.E. papers on this station have been presented by Charles W. E. Clarke, consulting engineer with Dwight P. Robinson & Co., who were the designers of the original plant and its successive additions. The original installation, which went into operation in December, 1920, consisted of one 60,000-kw. three-element turbo-generator and seven cross-drum water-tube boilers operating at 275 lb. pressure and 600 deg. abs. Heat balance was maintained by apportioning the auxiliary motor load between a 2,000-kw. house turbine and a 750-kw. motor-generator set. The second installation, comprising another 60,000-kw. unit similar to the first, and six more boilers, went into operation in 1922.

At the present session the engineering history of the Colfax station was brought up to date by a paper in which Mr. Clarke described the latest extension and its effect upon operating results. The following abstract covers points of particular interest.

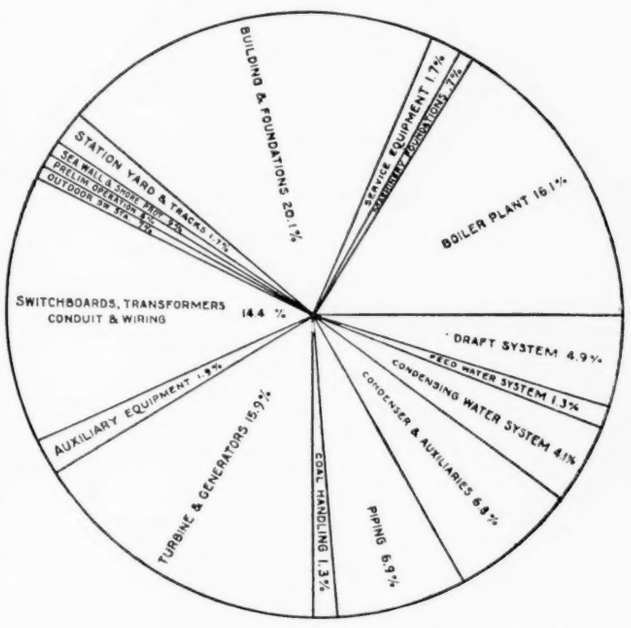
In 1923, when the third extension was being planned, due consideration was given to the advances that had been made in steam pressure, heat balance, combustion, etc. It was decided to use the same steam pressure, but to increase the temperature to 650 deg. abs. Pulverized fuel was adopted along with four-stage bleeding and an auxiliary generator on the main-unit shaft. In place of one large unit two 35,000-kw. multiple-exhaust turbines were added.

In addition to five new pulverized-fuel-fired boilers of 27,680 sq.ft. each, one 22,914-sq.ft. stoker-fired boiler, similar to those furnished with the second unit, was installed. The five pulverized-fuel boilers are 47 tubes wide and 20 tubes high, the tubes being 24 ft. long. The boilers are equipped with fourteen burners each, set in two batteries of seven each. Increased combustion space has been provided by placing the drums five feet higher than in the first and second installations. The superheaters are of the inter-deck type.

Two six-ton-per-hour pulverizing mills are installed with each boiler. Fans force air through plate-type preheaters, air ducts and furnace walls, delivering the air to the combustion space of the furnace at about zero pressure.

Two of the boilers have furnaces constructed with hollow side and front walls through which the preheated air passes before it enters the furnace. The rear walls of these furnaces are protected by plain-tube water screens. These boilers have been in operation since October, 1924, and the furnaces are in good condition. It has been found, however, that with CO_2 higher than 13 per cent the furnace walls will slag and run. The other three boilers have furnaces constructed with fin-type water screens on the sides, plain tubes on the rear walls, and hollow front walls. They have been in operation since July, 1925, and can apparently carry a considerably higher CO_2 without appreciable slagging. Fin-type coolers are now being installed in the side and rear walls of the first two boilers.

All these furnaces have water screens across the ashpits which are constructed with hollow-lined bottom and are air cooled. Clinker and ash are removed by sluicing.



Cost diagram, Colfax Station, Capacity 190,000 kw.

All auxiliaries are electrically driven except the air pumps, which are of the steam-jet type. While the principal auxiliaries of the main units are normally carried by the house generators, a device known as a "voltage chaser" automatically switches them to the station house bus or back in case of loss of voltage on either.

Condensate is normally used to cool the generator air coolers, transformers, turbine-bearing oil and steam-jet vacuum-pump condensers. Emergency provision has been made for the use of raw-water cooling.

The over-all boiler-room efficiency of the Colfax Station from July, 1924, to July, 1925, averaged 79 per

cent. The average from March, 1922, to November, 1924, was 75.4 per cent. Most of the difference is due to the improved boiler-room efficiency of the last unit installed.

The net over-all station performance, in B.t.u. consumed per kilowatt-hour, was 19,800 for 1922, 19,450 for 1923, 18,550 for 1924 and 17,750 for the first three-quarters of 1925. The yearly average curve shows the effect of the installation of preheaters, pulverized-fuel system and four-stage bleeding, which was started in 1924 and was completed in 1925.

As at present arranged, a determination cannot be made of the heat consumption of the third-unit turbine-room installation by itself. Tests have been made, however, which show the following turbine-room heat rates from the boiler nozzle in B.t.u. per net kilowatt-hour delivered: Full load, 12,752; three-quarters, 13,021; half load, 14,200.

Experience at the Colfax Station does not confirm the prevailing opinion that extremely large turbo-generators are unreliable. The outages have not been excessive.

Coming to the vital matter of costs, it has not been customary to publish such details of power stations, and the author found it difficult to obtain them outside of his own organization. Although no detailed costs are given in his paper, the author would be glad to exchange them with anyone interested.

The following totals include all costs for the power station, sea wall, intake and discharge tunnels, outside switching stations, and all overhead costs such as engineering and construction fees:

The cost of the Colfax Station at the completion of the second unit was $13,982,000, or $116 per kilowatt for an installed capacity of 120,000 kw. The third unit installation, of 70,000-kw. capacity cost $8,019,000, making a total cost to date of $22,001,000, or $116 per kilowatt for an installed capacity of 190,000 kw. This cost includes buildings, foundations, reserve boilers and service equipment which are applicable to the fourth unit.

At the present time the Duquesne Light Co. has under way the installation of a fourth unit of 80,000 kw. capacity at an estimated cost of $7,025,000, which would give a total installed capacity of 270,000 kw. at a total cost of $29,026,000, or $107 per kilowatt. These figures are exclusive of an outside coal-handling plant and a coal railway to the mines constructed at a total cost of $422,000. It will be noted that the unit cost decreases as plant additions are made, owing to the necessity of constructing buildings and installing equipment which also serve the future additions.

Discussion on Mr. Clarke's Paper

In discussing this paper, Prof. F. O. Ellenwood (Cornell) said that actual cost data on air heater installations were needed as a basis for determining their commercial value. Mr. Clarke replied that such matters could not be treated piecemeal, since the use of air heaters effects the design of the whole station. Only the effect on over-all plant cost and performance is of value for purposes of comparison. The 4-stage bleeding cycle used at Colfax, he said, showed a return of 20 to 25 per cent on the actual additional investment.

In the opinion of H. W. Leitch, general superintendent power stations, United Electric Light & Power Co., and of Joseph S. Bennett, of the American Engineering Co., a casual study of Mr. Clarke's paper might lead to erroneous conclusions as to the relative efficiencies obtainable with pulverized fuel and with stokers. Mr. Leitch referred to a 24-hour test at Hell Gate, where a 35,000-kw. generating unit with three 15,900-sq.ft. stoker-fired boilers produced 639,000 gross kilowatt-hours from 643,000 lb. of coal, equivalent to 14,080 B.t.u. per gross kilowatt-hour generated. Mr. Bennett decried the custom of comparing old stoker installations with the latest thing in pulverized coal. A big advance had been made, he said, in the matter of ashpit loss, this being in many cases reduced to less than one per cent of the heat in the coal burned.

The new Toronto Station of the Ohio River Edison Co. is now operating on an over-all heat consumption of 16,000 B.t.u. per net kilowatt, according to R. J. S. Pigott, consulting mechanical engineer for the Public Service Production Co. (New Jersey). The designers expect the 15,000-B.t.u. mark to be reached. Boiler ratings are high (300 per cent continuous and 400 per cent maximum). Early troubles with excessive smoke are being ironed out by automatic combustion control and by paying more attention to primary air supply, burner location, etc.

In his closure Mr. Clarke agreed that there had been a great improvement in stokers. He said Colfax, like Toronto, had experienced some trouble with smoke, and that this was being corrected by increasing the primary air up to 40 per cent of the total.

Steam Bleeding and Turbine Performance

THE paper presented by C. D. Zimmerman (production engineer, steam department, Cleveland Electric Illuminating Co.) on "Steam Bleeding and Turbine Performance" was not of such nature as to permit much of practical value to be given in a brief abstract. The following comments will indicate the general scope of the paper.

Its primary object was to show by test data the effect of single-stage steam bleeding (for feed heating) on over-all station economy.

Many complications were introduced by the fact that any change in pressure or quantity of bleed steam affects not only the turbine performance, but that of the condenser, boiler, superheater, economizer, etc.

The tests were made at the Lake Shore Station of the Cleveland Electric Illuminating Co., and the turbine tested was a Curtis-type 17-stage machine of 30,000-kw. capacity. Steam was bled from the 13th stage.

The curves presented showed the following relations: Effect of bleeding on turbine steam rate and on condenser back pressure; the effect of amount of steam condensed on condenser back pressure; effect of quantity of steam bled on bleeder pressure, heat transfer in bleeder heater, feed-water temperature and on net heat consumption of turbine unit; effect of feed-water temperature on boiler and economizer efficiency; effect of bleeding on boiler rating with the resulting effect on boiler efficiency; effect of bleeding on gross B.t.u. per kilowatt-hour; effect of feed-water temperature on gross B.t.u.; financial saving with changes in feed-water temperature; effect of condenser back pressure and superheat on turbine water rate, etc.

As all the numerical values shown apply only to the particular equipment listed the chief value of the

paper is that it indicates the scientific method of attacking such a problem where extensive facilities for testing are available.

Discussion on Mr. Zimmerman's Paper

Mr. Zimmerman's test results brought out one point of special interest, namely, that superheat and vacuum have a larger effect than has commonly been assumed by station designers. These matters, therefore, deserve further study.

In the discussion M. K. Drewry, of the Lakeside Station (Milwaukee), brought up the much-discussed question as to whether bled steam can relieve a turbine of excess moisture. He knew of one careful test where nothing of the sort occurred.

With more stages of bleeding and increasing feed temperatures the economizer has less to work on, according to R. J. S. Pigott. This favors the air heater for such stations. C. G. Spencer, of McClellan & Junkersfeld, thought the economizer might be justified with single-stage bleeding.

The discussion brought out an interesting experience with bleeder heater drains. The heater condensate was discharged to the condenser hotwell through a drop-leg seal of sufficient height (supposedly) to take care of the difference in pressure between heater and condenser. As a matter of fact, flashing of water into steam in the seal produced an air lift effect with the result that the seal was blown dry.

Radiation in Boiler Furnaces

B. N. Broido

IN HIS paper on "Radiation in Boiler Furnaces," B. N. Broido[1] said that the increasing use of water-cooled furnace walls makes it necessary that the designer know (1) what quantity of water can be evaporated by a given area of radiant-heat absorbing surface, (2) what will be its influence on the furnace temperature and combustion and (3) what amount of heating surface can be placed in a furnace in order to obtain the best possible results.

Radiation and the Radiation Coefficient

Heat transmission by radiation occurs only from surface to surface, without giving heat to the gas between the two bodies. It is difficult to determine by test the amount of heat radiated or absorbed, but the formula of Stephan and Boltzmann, according to which the radiation from a body is proportional to the fourth power of its absolute temperature, is sufficiently accurate for practical purposes for any non-transparent body, with suitable coefficients.

The calculation of heat radiated in any actual case is an elaborate mathematical task. Mr. Broido refers to several books and papers giving methods suitable for boilers.

The radiation from a clear flame is almost wholly due to CO_2 and water vapor, regardless of the nature of the fuel. Moreover, radiation increases with flame thickness up to about two feet. Radiation from a luminous flame is probably considerably greater than that from a clear gas flame at the same temperature because of hot particles which make it a more effective radiator. Also the surface of the flame is much greater than that of the fuel bed, so that flame radiation may be some 60 per cent of that of the fuel bed.

In a furnace with water-cooled walls the gas temperature is lowest at the wall and gradually increases toward the center of the furnace for 4 to 5 ft. depending upon the rating of the boiler. The flame or gas is not transparent to its own radiation for more than 3 ft., but there is undoubtedly a mixing of the gases so that the radiant heat absorbed by the wall affects a considerably greater gas thickness.

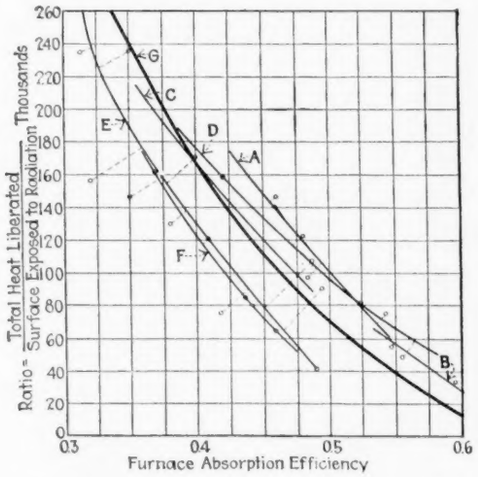


Fig. 1—Variation in furnace absorption efficiency with heat liberated

Heat Absorption by Radiation

The heat absorbed by radiation per square foot of surface depends upon the amount of fuel burned and the amount of heating surface that is located in the furnace, both of which influence the temperature of the gases in the furnace.

The fraction of generated or liberated energy that is absorbed by radiation seems to be related to the ratio of the total heat generated in the furnace to the amount of surface exposed to direct radiation. In Fig. 1 curves give values for different cases. The variation for the six cases is less than 20 per cent, so that the average value of curve *G* is sufficient for practical calculations.

The heat absorbed per square foot of surface is dependent upon the way the heating surface is considered, as shown in Fig. 2. In order to avoid misunderstanding in speaking of water-screen surfaces, Mr. Broido recommends as a standard that the projected area be used.

Most Advantageous Amount of Radiant Heat Absorbing Surface in a Furnace

The amount of water-cooled surface that can be installed without affecting combustion is dependent upon the kind of coal used and the fusing temperature of the ash.

When low-grade coal is used, it is very desirable to keep the walls cool by water tubes. Enough refractory must be used, however, to reflect sufficient heat so that the temperature of the gases over the entire surface is not lower than that required for combustion.

[1] Consulting Engineer of the Superheater Co.

If mixing of air and gas could be maintained, the ill effect of water tubes could be minimized. Preheated air would also reduce this effect. From some points of view, water-cooled walls are more beneficial for stokers than for powdered coal.

Anything that will burn at all will ignite in an ordinary furnace at about 2,000 deg. F.; the problem of combustion is not how to combine the oxygen and carbon when brought together, but how to bring them together.

Fig. 2 shows a boiler, now under construction, designed with a circular furnace to take full advantage of flame radiation. Mr. Broido describes several types of water-cooled walls installed in various plants.

Heat transfer from gases consists of two components, one by convection and the other by radiation. As the heat transmitted by convection varies with the gas velocity while the radiant heat is independent of this factor, it is important to have high gas velocity only where the heat absorbed by convection is dominant, that is, only in the last passes. In passes nearer the furnace where the gas temperatures are high, it is rather desirable to have low gas velocity to increase the radiant effect through increased time of exposure.

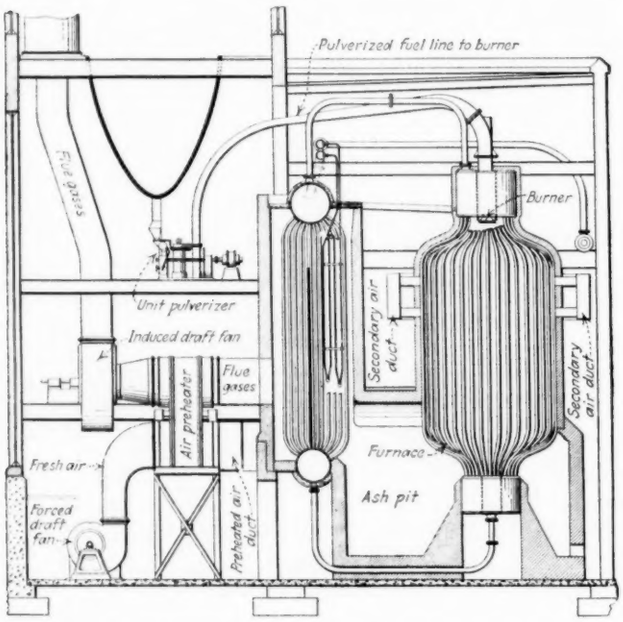


Fig. 2—Preliminary design of boiler now being installed with furnace entirely surrounded by water cooled surface

In discussing Mr. Broido's paper, George A. Orrok presented a modification of Hudson's formula indicating that the fraction of the total heat available in the furnace which is transmitted by radiation is

$$R = \frac{1}{1 + \frac{A\sqrt{C}}{27}}$$

where A = Lb. air per lb. coal;
C = Coal burned, lb. per hour per sq.ft. of radiant heat absorbing surface.

The remaining heat available from the fuel must be *available* for transmission by convection, so that the temperature of gas entering the convection portion of the boiler can be computed. This, together with the temperature of exit gas, makes it possible to calculate the heat actually transmitted by convection. Thus the total heat absorbed by the boiler is calculated, and the boiler efficiency may be predicted. Convection affecting the radiant surface is considered as radiant heat, and radiation affecting the convection surface is considered

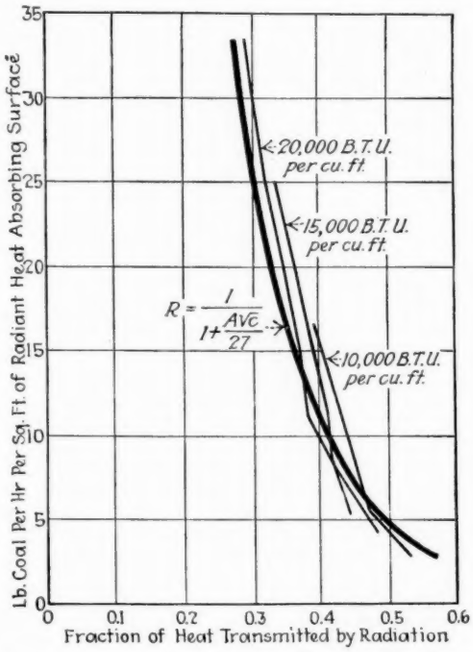


Fig. 3—Hudson's formula, modified by Orrok, is shown by the heavy line to agree closely with test data as shown by the light lines

as convection heat. The computed temperature may not be quite correct, but the variations are not as large as observed pyrometer variations.

Fig. 3 shows the close agreement between the results of Hudson's formula and test results obtained by others. A large number of boiler tests have been checked up by Mr. Orrok, who has thereby demonstrated the reliability of his modification of Hudson's formula. The formula is quickly worked on the slide rule, a simple calculation giving all necessary quantities to check a complete boiler test or a new design.

Prof. A. G. Christie pointed out that bodies which are transparent to light may not be transparent to heat radiation, and that they may either reflect such radiation or absorb and reradiate it. Which of these actions characterizes CO_2 and water vapor has an important bearing on the study of the effect of water-cooled furnace walls, and further investigation is needed to determine this point. Professor Christie doubts Mr. Broido's conclusion that the effect of water-cooled walls is confined to a layer of gas next the wall. He does not agree with the author that a radiant heat absorbing surface should be figured as projected area. This is not done for any other heating surface, and, Professor Christie believes, would lead to difficulties.

Professor Christie further believes that a water-cooled furnace with small heat storage would respond to sudden changes of rating more rapidly than a furnace with refractory walls.

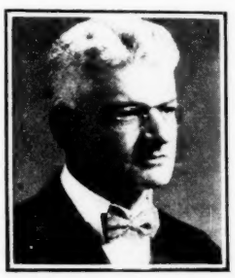
Professor Wohlenberg, of Yale, stated that in the preparation of his radiation studies he used the same coefficients as Mr. Broido, and discussed the relation

between the coefficient and the furnace temperature. He objected that the average curve presented by Mr. Broido is of the wrong shape, in that it should turn more nearly horizontal at its lower end. In establishing curves of this nature, it is important to consider their trend when extended to limiting conditions. Another important feature discussed by Professor Wohlenberg is the matter of furnace symmetry in relation to furnace volume and the proper presentation of results. He confirmed the correctness of Mr. Broido's choice of the heat liberated per square foot of absorbing surface as the basis of comparison.

H. H. Suplee, of New York, reported the successful operation of water-cooled furnaces in connection with water-tube boilers prior to 1885 and showed a patent on such construction granted to him in 1883.

E. H. Tenney, of St. Louis, pointed out the importance of flame turbulence to the securing of complete combustion with water cooled walls.

The Unit Coal Pulverizer



R. Sanford Riley

THE paper on "The Development of a Unit Pulverizer," by R. Sanford Riley and Ollison Craig, describes a series of experiments through which they have worked out a satisfactory design of coal pulverizer of the unit type.

Starting with a machine manufactured in England, the authors conducted a series of tests with various modifications of the original design. In their paper they report the results of 13 of these tests, each with a different arrangement of internal mechanism.

The authors consider the characteristics of a unit pulverizer to be in the following order of importance: Reliability, ability to pulverize wet coal, power consumption, low maintenance, fineness of pulverization.

The original English machine seemed to fall short of the ideal set up by the authors when operating with American coal. The machine did, however, pulverize coal to an extreme fineness. Accordingly, the machine was redesigned to reduce maintenance and the unnecessary fineness was reduced so as to decrease the power consumption.

In its final form the machine comprises a first effect, which is a swing hammer crusher, and a second effect, in which a series of stationary and moving pegs made of hard cast iron bat the coal about as it is drawn through in a stream of air from the outside toward the center. The coal then passes through a fan that is part of the machine and is discharged directly to the furnace burner.

This final design operates with high reliability and permits foreign material to enter the machine without injury. The machine is able to pulverize very wet coal, especially when hot air is admitted to the first effect. The power consumption varies from 9 to 14 kw.-hr. per ton of coal. A redesign of the pegs and a selection of very hard metal has reduced maintenance and resulted in a decidedly longer life of pegs, and the design makes possible their replacement with ease and speed.

With respect to fineness the performance is satisfactory, only a trace of the coal remaining on a 50-mesh screen. The proportion of fines is high, some 90 per cent passing 200-mesh.

The pulverization is independent of wear of the pulverizing elements. The degree of fineness is substantially the same after 1,000 tons have been pulverized as when all parts are new.

The paper discusses in some detail the phenomena taking place within the pulverizer, and the authors endeavor to apply a rational analysis to the performance of this class of equipment. They hope that this effort may stimulate research along this line and thus advance the art.

Discussion of Mr. Riley's Paper

In discussing this paper, G. B. Randall, of Dayton, Ohio, expressed strong preference for the unit pulverizer and said that he expects machines of this class to take a commanding position.

E. L. Clifford, of New York, called attention to the importance of safety against explosion, which may be jeopardized by an incorrect air supply. Such conditions are created during the starting and stopping periods, and it is of paramount importance to keep tramp iron out of the machine. He raised the question of dependability and the need for standby equipment, inquiring whether duplicate mills were required.

Mr. Clifford further discussed the effect of moisture, citing tests that have indicated a higher boiler efficiency with moist coal than with dry coal, perhaps due to the loss of small dry coal particles before they are burned or to some chemical effect of the moisture. He stated that with the unit pulverizer, since all of the moisture passes up the stack in any case, there is no thermal gain from the drying effect of the mill, as there is in the case of a storage system of preparation and burning.

In discussing maintenance, Mr. Clifford said that there is a tendency toward moderate fineness requirements, perhaps 60 per cent through a 200-mesh, with all the coal passing 40- or 50-mesh.

M. J. P. Moore, of the stoker department of the Westinghouse Electric & Manufacturing Co., pointed out that the source of coal has a large influence on the power required to pulverize it. He further pointed out that it is desirable to have the power consumption as uniform as possible at various rates of coal feeding.

J. K. Blum, of New York, said that in his experience, the power curve was not a straight line, as shown in the paper, but tended to turn upward at high rates of grinding. The quality of materials which might be called "grindability" varies widely, and a successful mill must be capable of handling the greatest possible variety of coals. He pointed out the need for a more definite standard of measurement of mill performance, and the necessity of grinding large quantities of various materials in determining power characteristics of any mill.

V. E. Alden, of the Consolidated Electric Light & Power Co., of Baltimore, said that while he could see good use for a unit pulverizer in displacing stokers in small plants, he was not so certain of its applicability to new large boiler rooms, where the number of units necessarily would be great, with consequent machine maintenance in the boiler room. The explosion hazard is seriously increased by the overhauling of mills in close proximity to operating furnaces. The increasing tendency toward the use of the regenerative cycle, he said, leads to the use of high air temperature, perhaps

as high as 600 deg. F., and he inquired concerning the effect of such hot air on the tendency of coal to liberate tar and become sticky, gumming the mill. He said that the saving in mill power indicated by the paper amounts to only three or four tenths of a point in the efficiency scale of the boiler room, and that this might be entirely offset by any slight loss in efficiency due to reduced flexibility of combustion control.

Professor Christie mentioned the need for data on outage, life, and maintenance, and inquired concerning the type of mixer and burner advocated by the authors of the paper. In connection with Mr. Alden's comment on the use of hot air, Professor Christie cited evidence that coal begins to give off tar at about 475 deg. F.

In closing the discussion, Mr. Craig described the mill feeder, and said that while automatic control had not yet been developed, the mechanism was well adapted to such a scheme. Tramp metal, and other rejected material, can be removed from the mill without interfering with its continuous operation. He described the type of mixing burner in use, and said that in taking samples for fineness tests, much care was exercised, explorations of the air-coal stream having been made in an effort to secure truly representative samples. In the tests reported, a Clearfield coal was used showing about 18 per cent volatile matter, 8 per cent ash, and 74 per cent fixed carbon. He said that just as for a stoker, better coals give better results, and that it is important to select a coal that is suitable for the apparatus used. With respect to maintenance he said that experience is as yet insufficient to justify any statement of expectations. He believes that it will compare favorably with mills of other types. The mill passes about 10 per cent of the air required for combustion. To pass more air through the mill would be wasteful of power, due to the high resistance of the mill to air flow.

Mr. Craig said that the dependability of the mill will be no less than that of the stoker, and that in case of outage it should be possible to restore mill service more quickly.

He said that he has detected no difference in combustion due to variation in moisture content of the coal up to 15 per cent. He cited tests made at the Iowa State College indicating higher efficiency with higher moisture, with underfeed stokers. He believes that this will not be true of pulverized-coal firing.

Interest Shown in Internal-Combustion Engines

THREE or four years ago papers on internal-combustion engines were notable for their absence at the annual meetings. Interest since then has increased to the point that four well-proportioned papers dealing with both oil and gas engines met a sympathetic reception.

Centrifugal Compressors for Diesel Engines

S. A. Moss

THE general methods of scavenging and supercharging of Diesel engines were covered by Dr. Sanford A. Moss, of the General Electric Co., with special reference to the centrifugal turbo-blower. Four systems of scavenging are followed. In one of these, that used in two-stroke-cycle semi-Diesel engines, the crankcase is used for the scavenging pump. In the second, or receiver method, a reciprocating air pump is used, discharging into a receiver that communicates with the engine cylinders through the air ports. The pump strokes may or may not be turned so that the discharge period synchronizes with the scavenging period of the working cylinder. If not, a more or less constant receiver pressure is carried, and both systems have advocates among Diesel engine experts.

The latest system embraces the use of a centrifugal blower delivering air at about two pounds pressure into a receiver or air manifold. This is the arrangement used on the motorship "Aorangi," which is propelled by four two-stroke-cycle Diesels of 13,000 total horsepower.

Such blowers have been used with four-stroke-cycle engines, the intention being to clear the clearance cavity of burnt gases and to fill the cylinder with air at slightly above atmospheric pressure, or supercharging the cylinder. This plan, so the speaker stated, is now being used on all large German four-stroke-cycle engines.

Supercharging Increases Output

When supercharging was adopted for the Norwegian motorship "Tiradentes," the engine output was increased from 3,100 to 3,600 b.hp. Although the exhaust gases showed no smoke, the exhaust valves had to be cleaned and reground every 40 days in place of every 60 days as was formerly the case.

The centrifugal blower has a volumetric efficiency of 75 per cent, which is higher than that obtained from the reciprocating air pump. It is also light in weight, cheaper to manufacture and requires less floor space than the blower.

A plan of using an exhaust turbine to drive a centrifugal scavenging blower which the speaker has been developing was mentioned. Experiments show an increase in the engine's power over that theoretically computed. This is attributed to the better mixture in the cylinder resulting from the complete scavenging. It was pointed out that the cylinder combustion temperature did not increase when supercharging was followed, since the weight of oil burned per pound of air charge was not increased.

In the discussion on Dr. Moss' paper, W. E. Ver Planck stated that the General Electric Co. had found that the efficiency of the turbo blower was approximately 75 per cent.

L. M. Goldsmith, Atlantic Refining Co., stated that his company was running tests on a solid-injection oil engine using a blower for supercharging. He was interested in learning if a bypass air intake should be installed on a supercharged four-cycle engine to be used when the supercharge was not in operation. To this Dr. Moss replied that a bypass should be used.

L. M. Griffith, engineer, National Advisory Committee for Aëronautics, stated that they had experienced trouble with fractured cylinder heads and piston heads due to excess heat stresses when supercharging.

Gas Engines in Steel Mills

Asa A. Raymond

THE gas engines of the Sparrows Point, Md., plant of the Bethlehem Steel Co. were covered in a paper by A. A. Raymond. The gas engines consist of eighteen units, ten of which are driving blowing tubs and six are direct connected to generators. The blowing units are two-cylinder four-stroke-cycle double-acting machines. The five installed in 1914 have cylinders 45 in. diameter by 60 in. stroke and the seven added at a later day are 47 in. diameter by 60 in. stroke. The generating engines are twin tandem with four cylinders 47 in. diameter by 60 in. stroke. Blast-furnace gas is used as fuel, after being washed in a Theisen washer.

The cylinders are made of cast steel of both simple and two-piece construction. The pistons are of the same material and are pressed and locked on the rods.

Gear-Driven Governor Operating Through Oil Relay

The governor, of the standard spring-loaded type, is driven by gears. It does not act directly on the mixing valves, but controls an oil-operated piston by means of a relay valve in hydraulic balance. The work required of the governor is constant regardless of the load of the engine or the physical condition of the mixing valves. This arrangement secures more rapid control under all operating conditions, which is extremely important for electric generators operating in parallel.

Operating records reveal that the heat balance of the engines is made up of the following percentages:

Heat converted into indicated work, per cent.	28.6
Heat lost in cooling water, per cent	28
Heat lost to exhaust	38
Radiation, etc.	34

Some of the waste heat in the cooling water and exhaust gears is recovered.

Besides the hot water furnished to the boilers from the circulation system, sufficient low-pressure steam has been generated during the winter months to supply heating coils in the oil filters and cylinder-oil pumps and furnish some heat in the buildings. This steam is generated by the use of heating coils placed in the exhaust headers, the coils being supplied with water leaving the engines at about 145 deg. F. The monthly output of steam is approximately 1,710,000 lb., the evaporation per engine horsepower being around 570 lb. per hour.

Electric Transmission for Internal-Combustion Engines

Herman Lemp

THE rapid development in the use of oil and gas engines for locomotives, rail cars, buses and electric machinery made the paper on the transmission devices by Herman Lemp, Erie Shovel Co., of interest.

He stated that although the internal-combustion engine is the most efficient prime mover today, as to power furnished per pound of fuel and per pound of power plant, it has certain limitations. It is not self-starting; it is not easily reversible, particularly not under load; when its torque is exceeded, it will stall and stay stalled.

To make its power available under all service conditions from maximum torque and minimum speed to minimum torque and maximum speed, some transmission has to be interposed between the prime mover and service application. This transmission may be mechanical, pneumatic, hydraulic or electric.

The mechanical is lighter and cheaper and is used in preference with light powers. With increasing weight and power, pneumatic, hydraulic and electric transmissions become imperative in the order named.

Pneumatics in small units, although inefficient under prevalent application, are practical when time, storage and distance of delivery are short and when superheat from the exhaust of the internal-combustion engine is utilized and flexibility of operation is of prime importance. A practical application to excavating machinery was cited.

Hydraulics are particularly suitable for heavy-torque slow-speed transmission, or in the form of a hydraulic differential gear, such as the Schneider gear, converting slip into useful torque while transmissing under normal locked condition directly without slip at maximum efficiency.

Electric transmission is considered from 15 to 30 per cent more expensive than mechanical from the viewpoint of first cost, but, being the most efficient and flexible transmission, subjecting the prime mover and itself to less shocks, makes a lower cost of maintenance possible.

Electric transmission is used in two principal forms: In connection with a prime mover running at nearly constant speed, in which case control of vehicle speed is obtained by varying the field excitation of the main generator; it is also used with a prime mover operated by a hand-controlled fuel supply at variable speed coupled with automatic speed torque control applied to a generator and exciter having a drooping characteristic.

Practical application of this automatic speed-torque control is shown in connection with three different branches of service: (1) Double-and single-deck busses for city and interurban traffic on streets; (2) self-propelled gas or oil-electric cars on rails; (3) gas and oil-electric switching locomotives for railroad centers and industrial yards.

The constant-speed generator-field control seems better suited for main-line work and operation of multiple units. The variable automatic speed-torque control is,

however, preferred for busses, single motor cars on rails, switching locomotives in railway and industrial yards.

Electric transmission efficiency in large units is very high—from 90 to 95 per cent.

In spite of higher first cost and weight, lower maintenance, as proved by 14 years of railroad experience and better all round service ability, has caused electric transmissions to be generally accepted as preferable for vehicles above 15 tons and they are even applied economically to vehicles of lesser weight.

Discussion

In discussing auxiliaries, Harte Cooke, McIntosh & Seymour Corp., stated that electrically driven auxiliaries were more efficient than steam units. He pointed out that the compressor capacity recommended by the authors was too small, inasmuch as at low speeds the compression output decreased while the engine's injection-air demands remained constant. W. H. Thompson, Davis Engineering Co., favored the use of fire-tube waste-heat boilers in preference to the water-tube type. He stated that such boilers placed no unfavorable back pressure upon the engine and in some instances the back pressure decreased due to the shrinkage of gas volume during cooling in the boiler.

Harold T. Anderson, Westinghouse Electric & Manufacturing Co., stressed the advantages of steam-driven auxiliaries using waste-heat steam. He did not favor the authors' suggestion of electric heating.

The proper selection of the deck machine and other auxiliaries for motor ships was covered by a paper by John W. Morton, chief engineer Diesel department of the American Brown, Boveri Co., and A. B. Newell, guarantee engineer. The authors favored electric motors supplied from the main auxiliary engine in preference to the use of donkey boilers and steam units.

Stress was placed upon the advantages obtained by installing waste-heat boilers, the statement being made that about 1 lb. of steam could be generated per Diesel brake horsepower. The authors had no definite recommendation covering the size of air compressors. Curves were given, indicating that no standardization is possible inasmuch as the design of fuel valve, kind of oil, etc., largely determine the pressure and volume of air needed.

Joint Meeting of the Mechanical and Refrigerating Engineers

IN A PAPER on "Centrifugal Compression as Applied to Refrigeration," read before a joint meeting with the American Society of Refrigerating Engineers, W. H. Carrier stated that the fundamental design of the centrifugal gas pump, or compressor, is identical with that of the modern centrifugal pump for handling water and other liquids. The principal departures from this design are entirely mechanical and are such that they tend to make the centrifugal compressor a more sturdy machine than the centrifugal pump. The centrifugal compressor uses much higher peripheral speeds than centrifugal pumps, and its mechanical construction, for this reason, resembles that required of a steam turbine, such as the use of large-diameter shafts and strong steel disks in the rotary members. Thin metal labryinths are used to prevent leakage between stages as in the steam turbine. These prevent excessive leakages that would materially affect the efficiency, but at the same time do not actually introduce contact with the moving parts. The centrifugal gas compressor is not subject to erosion or wear at the points of clearance as is the centrifugal pump.

Various means are employed in different types of pumps and compressors for converting velocity head into potential energy or static head. The first of these, and perhaps the most efficient if properly designed, is the use of guide vanes to form a series of diverging nozzles in which the velocity is gradually reduced from the periphery of the impeller to the outer chamber of the casing. Another method is to use a free vortex ring which tends to change velocity into pressure in accordance with definite physical and mathematical laws which will not now be considered. The third and very common method, especially in the more simple types of equipment, is to use a scroll that is in effect a single continuous diverging nozzle.

With proper design the first method is perhaps somewhat more efficient and possesses certain advantages in compound compression where a series of rotors are employed. This is merely the principle of the diverging nozzle, as in the venturi meter, in which the area of the nozzle is gradually increased and the velocity is correspondingly reduced. The exact efficiency of such a nozzle in conversion of the form of energy from velocity to pressure may be as high as 85 per cent, but usually it is somewhat lower. The efficiency of conversion in the stationary member or casing in no way affects the power required to drive the rotor for a given condition, but only affects the effective head produced.

While the head is independent of the gas density, the ratio of compression increases as RT decreases. However, R, the gas constant, is inversely proportional to the specific weight or approximately inversely proportional to the molecular weight. Therefore, the greater the molecular weight of the gas and the lower its temperature, the greater will be the ratio of compression for the same effective acceleration. This effect on the ratio of compression increases in a logarithmic or geometric ratio with the molecular weight.

The effect in compounding a centrifugal compressor is obviously to increase the ratio of compression in a geometric ratio provided the temperature remains constant. It is desirable in refrigeration to use a vapor having a low value for k, as well as high molecular weight. Fortunately, these two relationships usually go together. The value of k increases with the number of atoms in the molecule, as does the molecular weight.

It is for this reason that dichloroethylene can be subjected to a considerable ratio of compression without the use of intercoolers and with little effect upon either the ratio of compression or the power consumption provided the compressor efficiency is reasonably good.

Turbine-Bucket Vibration

Wilfred Campbell
(Deceased)

PECULIAR personal interest attaches to the paper on "Tangential Vibration of Steam-Turbine Buckets," by Wilfred Campbell and W. C. Heckman, due to the fact that Mr. Campbell, who had devoted several years of intensive research to this problem, died on July 7, 1924, shortly after presenting a paper on the same subject before the Spring meeting of the Society in Cleveland. He had intended to prepare this present paper, which has been made up from his letters and memoranda with few alterations. Mr. Heckman has continued the researches of Mr. Campbell.

The importance of vibration to the turbine designer and operator is due to the fact that any vibrating body tends to develop cracks and will ultimately break.

A bucket may vibrate in two directions, (1) approximately perpendicular to the plane of the wheel (axial vibration) and (2) approximately in the plane of the wheel (tangential vibration). Mr. Heckman discussed the latter at some length, reporting the results of many tests on both stationary and rotating bucket wheels.

The problem is almost entirely confined to long exhaust stage buckets, since shorter and stiffer buckets have natural frequencies far above running speed.

Mr. Heckman said that the cause of tangential bucket vibration is resonance; that is, the bucket, vibrating as a reed, has a natural frequency in vibrations per second which is 2, 3, 4, etc., times the revolutions per second of the turbine. Of course, if there were no force acting, vibration would never begin, but such forces always exist in a steam turbine, and some of them, at least, occur once per revolution, and are therefore able to set up and maintain vibrations whose frequency is a small multiple of the machine speed.

The way to prevent vibration, said Mr. Heckman, is simply to tune the wheels and buckets so that their natural frequency is not a small multiple of the turbine speed. This is done by suitable design of buckets, shroud bands, lacing wires, etc. This work must be done accurately, but the information now available makes it possible to do this with a high degree of reliability. As a result there has been a real advance in the art of designing large wheels for the exhaust stages of turbines, with growing confidence in their complete dependability.

Belt-Tension Ratios

THE Tuesday morning session, devoted to machine-shop practice, included a paper of some interest to power-plant engineers. This was "The Tension Ratio and Transmissive Power of Belts," by C. A. Norman, professor of machine design in Ohio State University. Professor Norman's tests, made on specially built apparatus in the University laboratory, were designed to give comparative values for belts of various materials and methods of manufacture. The results obtained were summarized as follows:

The conclusions one would draw from the tests here reported are as follows: The transmissive power of belts on cast-iron pulleys shows in general and within certain limits a tendency to increase with the slip. This tendency is especially marked in the case of certain mineral-tanned leather belts, and of oak-tanned belts that have passed through a running-in period. It occurs, however, also in the case of rubber belts, balata belts and various impregnated textile belts.

In the case of certain rubber belts and balata belts the increase of transmissive power with slip reaches a maximum beyond which no further increase takes place. The percentage of maximum tension turned into effective pull may, however, remain creditable even beyond this point. In other words, the belts do not need to be over-tightened.

The percentage of maximum tension turned into effective pull is greatest for the special mineral-tanned belts investigated; is very high also, especially at some slip, for a leather belt that has been run for a short time; and is high for balata belts. It exceeds 60 and even 70 per cent for some rubber and impregnated fabric belts.

New oak-tanned leather belts, not run in, convert into effective pull a smaller fraction of the maximum tension. Rubber belts, balata belts, certain textile belts, and the special mineral-tanned belt give their full service from the very start. A few months of running does not seem to impair the transmissive power of rubber belts.

These conclusions are of course strictly applicable only to the belts tested and to the test method used. The results seem to agree with certain tests on running leather belts, however.

Power Plant Materials

THREE papers were presented at this session. In the first one Prof. A. E. White presented some interesting "Heat Treatment Data on Quality Steel Castings." His summary of a study that had been made on the subject gave results of laboratory tests on dendritic and dentrite free steels after an annealing, a normalizing, a drawing, and a spheroidizing treatment. Numerous plant tests were included in the paper. The conclusions reached were that a normalizing and drawing treatment gave results superior to those obtainable by annealing or spheroidizing.

In his paper on "Bolts for Use in Power-Plant Construction" William P. Wood made it evident that in addition to proper conformance to dimensional requirements more careful scrutiny must be given to the physical properties of bolts and nuts. In a study made of a large number of bolts used in the construction of a power plant one of the conditions that became apparent was the indiscriminate use of steel and wrought iron as bolting material. It was granted that the use of wrought iron might be feasible in some instances, but at least it should be stipulated that the wrought iron be of as good quality as possible. That this was not always the case was made evident by photomicrographs showing sections from wrought-iron steam-line bolts.

Numerous instances were found where shanks of bolts had been made from steel and the nuts from wrought iron and frequently from a poor quality of "bundled scrap." While it was quite customary to use a material in the nuts somewhat inferior to that used

in the bodies of the bolts, the use of such poor stock was to be condemned.

To check up the common assertion that wrought iron exhibits greater ductility than any type of steel, tensile tests were made upon a series of 71 steam-line and valve bolts, with the result that the average ductility of the wrought-iron bolts, as shown by the percentage of elongation and percentage reduction of area, was about 18 per cent less than that of the mild-steel bolts, and no better than that of the high-carbon and heat-treated steel bolts which possessed much greater elastic limits and tensile strength.

Another situation was the use of screw stock as a material for nuts. Because of the treacherous brittleness of this material the practice was more dangerous than the use of wrought iron.

In a lot of bolts and nuts examined it was found that two-thirds of the nuts were made from a low-chrome steel, while the other one-third were made from screw stock. Almost invariably a bolt that carried a screw-stock nut on one end had a chrome-steel nut on the other end. At best such practice was inconsistent. Screw stock was not considered a satisfactory material for steam-line-bolt nuts.

It was pointed out that the first requisite of good bolting was a sufficient amount of ductility, but when a bolting material failed from lack of strength, there was danger of going to the opposite extreme and increasing the strength at the expense of the ductility. Conclusions reached from a study of this subject were that the best carbon content for bolting steel was somewhere between 0.10 and 0.6 per cent and that a range from about 0.20 to 0.45 per cent would yield the best combination of tensile strength and ductility in either the heat-treated or unheat-treated condition.

From the numerous examples in the paper and others that might be cited, it was obvious that some standard procedure in regard to the type of bolts to be used in the construction of steam-power-plant equipment should be adopted. A tentative specification for high-temperature-alloy bolting, which had been prepared by a committee of the American Society for Testing Materials was included in full in the paper for the consideration of the Society.

Increased Steam Pressures Affect Bolting Practice

In the discussion of the paper W. F. Oberhuber referred to the growing importance of bolting as the pressure in power plants increased. Carbon steel was not desirable material, as with bolts stressed beyond the elastic limit, joints could not be kept tight. For this reason high tensile strength in bolts was highly desirable. Studies that had been made showed that the stress on the fibers of bolting material increased in direct proportion with the load and as the length of the wrench used to pull up the nut. Heat-treated alloy steel had high elastic limit and was much preferable to carbon steel for bolts. The large amount of slag in wrought iron and the low elastic limit made it an undesirable material to use. The speaker favored chrome vanadium steel as the better material for bolting. A great work still remained to be done in finding the cause of the development of brittleness in pipe-line material, and he felt that a proper schedule of wrench lengths should be worked out.

L. W. Spring agreed in the main with the author's objections to the unsystematic method of using materials for bolting. High yield point in bolts often was more desirable than ductility, as the bolts would be stiffer and stronger. Ductility was of service only after the yield point had been passed. In service it was desirable to have the stress on bolts below the yield point. The author pointed out that open-hearth screw stock was available as well as the bessemer screw stock to which the author referred, and that more of it was being used for the manufacture of small parts that the poorer grades of bessemer, but in any event no screw stocks should be considered in power-plant work. Mr. Spring presented a comprehensive table giving the qualities of various kinds of steel.

W. W. Boyd discussed the various methods of making steel for bolts and the purposes and effects of annealing, hardening, tempering, etc.

G. H. Malcolm outlined briefly the troubles encountered in making bolts. One of the chief difficulties was to get steel of uniform chemical and physical properties heat after heat. Attributing bolt failures to crystallization was erroneous. Fatigue or progressive failure was the term. The speaker explained the effects of phosphorus and sulphur. One of the chief things the manufacturer had to guard against was dirty steel. A surface notch or stress greatly enhanced the internal stress. Primary and secondary piping was another danger in bolting. For the manufacture of bolts, all steel should be given a visual inspection. Small samples should be cut from each bar and analyzed and tested in tension and impact. If of doubtful quality the metal should be given a Brinell test.

Recent Studies in Refractories

In the final paper on "Furnace Refractories" E. B. Powell gave an instructive summary of the recent studies that had been made on present materials and how they were effected under operating conditions. Some of the factors considered were slag penetration, fusion tests of slag mixtures, load-carrying capacities of brick and the effect of various temperatures of burn, front wall erosion, temperature changes in firebrick in pulverized-coal burning furnaces at various distances from the fire face, spalling, distortion in structure and the burning characteristics of a number of special refractories.

In the discussion of the paper reference was made to an analyses of the operation of twelve boilers over a long period of time showing that outage from brickwork was twice that of all other causes. Extended trials of twenty different refractories in pulverized-coal firing with low-grade fuel failed to bring out any outstanding material. One of the benefits accruing from water-cooled walls was the elimination of refractory troubles.

By the West Penn Power Co. tests had been made on a large number of firebrick and bonding materials in a special experimental furnace equipped with slag ovens in which operating conditions were reproduced. From these ovens molten slag ran down over walls made up of the test brick. In this way the types of brick best adapted to withstand slag erosion and spalling were determined.

Other matters discussed were the use of plastic materials for wall repair, thin and thick mortar, cements and the greater need of expansion joints as furnaces grew larger.

Four hundred manufacturers took space at this year's exposition

Fourth Annual Power Show Has Many New Features

BIGGER and better is the term that best characterizes the fourth National Exposition of Power and Mechanical Engineers, which was held in the Grand Central Palace, New York City, during the week of Nov. 30 to Dec. 5. As this show is held simultaneously with the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers, it afforded engineers from all parts of the country an excellent opportunity to come into intimate contact with the power-equipment manufacturers and their products.

At the first exposition there were 120 exhibitors, at the second 260, last year the number increased to 370, and this year saw the number reach the 400 mark, so that the infant born three years ago has now grown to full manhood. Not only have the number and size of the exhibits increased, but also the attendance. Three years ago at the first show, 47,000 attended; this year the records will show close to 100,000.

One of the most gratifying features of this year's show was the number of large manufacturers that took space who did not see fit to do so in previous years. It can be said that practically all the large manufacturers of steam-electric power-plant equipment in this country were exhibitors this year and made the exposition more nearly national in its scope.

Another outstanding feature was the size of some of the equipment in the various booths. This included a coal-pulverizer rated at 12,000 lb. per hour; a 2,000-cu.ft. per min. compressor direct-connected to a synchronous motor; a 12x6-ft. stack breeching with an air-cooled damper supported in ball bearings; five sections of a lead-lined economizer; and a stoker designed for service under an 8,000-sq.ft. boiler. The marked increase in size of the equipment exhibited, the increase in the number of exhibitors and in many cases the enlarged space taken by them made vacant space on the three floors occupied by the exposition, conspicuous by its absence.

An improvement in the exhibits was the number of working models of equipment and in some cases actual full-size equipment in operation. For example, a coal-pulverizing plant equipped with a conical ball and tube mill was in operation, pulverizing river coal, that is, hard coal pumped from the bottoms of rivers in the coal regions of Pennsylvania, that has come down from the washers at the mines. Another manufacturing company had a working model of its type of boiler operating a steam engine. The boiler was arranged so that its operation could be seen through glass sections. Another exhibit included a small gas-fired boiler controlled by a centralized system of combustion control and supplying steam to a widely fluctuating load. With this equipment all the effects of changed conditions in the furnace and load changes on the boiler could be demonstrated. These and many others added much interest to the exposition.

Viewing the exhibition as a whole, the boiler plant was the part of the power house that was very much in evidence, from meters, valves and refractories to the larger equipment including boilers, stokers, pulverized-coal equipment, and combustion-regulating apparatus.

Many improvements have been made in high-pressure and high-temperature valves. Some of these include valves made entirely of Monel metal. There were nine types of coal pulverizers exhibited, four of them for the first time and three of comparatively recent development. Water-cooled and air-cooled furnace walls were much in evidence, and boiler-room instruments included a wide range.

In combustion-control equipment the variety of apparatus was extensive, ranging from a system for the complete control of a boiler plant, from a master controller to individual regulators for a damper. There were four centralized systems of combustion control exhibited for the first time, all of which were arranged so that they could be demonstrated and in one case the system, as applied to a commercial boiler plant, was in operation as mentioned on a gas-fired boiler. One could not help, after inspecting the great variety of equipment, being impressed with the fact that the manufacturers are wide awake to the possibilities of conserving our fuel supply by more efficient combustion.

Fig. 2—View of show from the mezzanine floor

Steam Turbines

In greater evidence than in former years was the number of large-sized commercial units on exhibition. A typical illustration was a 700-hp. turbine of the Terry Steam Turbine Co. The unit shown was designed for 550 lb. pressure, 750 deg. temperature and to operate with 80 lb. back pressure. A smaller unit of 120 hp. direct-connected to a herringbone reduction gear was also shown. Recent improvements made to the reduction-gear unit include the use of a large strainer so designed and located on the machine that it can be cleaned with the machine in operation.

The Moore Steam Turbine Co. showed a three-stage turbine, speed-reduction unit and a single- and multi-stage centrifugal pump, also parts of both turbine and pump to demonstrate the design and constructional features of the machines.

The DeLaval Turbine Co. included in its exhibit several types of reduction gear units in worm and spur gear drives and in horizontal and vertical types. Two of the types shown are of recent development. A feature of the exhibit was a double-reduction worm gear having a ratio of 975 to 1 connected through a 6 to 1 speed up gear to a small turbine unit, the whole being driven by means of a 15-in. fan mounted on the high-speed shaft of the double reduction unit and driven by air blown against it by another 15-in. fan. Other reduction units of the horizontal and vertical types and of recent design were those of the Foote Bros. Gear & Machine Co. and the W. A. Jones Foundry & Machine Co.

Pulverized-Coal Equipment

The exhibits of pulverized-fuel equipment were numerous and extensive. The Fuller-Lehigh Co. had a miniature model of its well-type burner (described in the June 9 issue) operating with city gas. This model clearly demonstrated the turbulent action that takes place within the burner. The exhibit also included single and duplex feeders, a 4-in. Fuller-Kinyon transport pump and a 1-in. model of the transport system equipped with electro-pneumatic switching valves, also a premixing burner for metallurgical furnaces and models of vertical and horizontal burners for boiler furnaces.

The Combustion Engineering Co. in addition to its regular line of pulverized-fuel equipment consisting of feeders and burners, fin-furnace wall, air-cooled furnace wall and air heaters, exhibited the Couch burner for horizontal firing and 5,000-lb. per hour "Impax" unit mill. An added attraction was a glass display which by means of an electrical scheme showed in washed-drawing effect an elevation of a furnace and boiler in which the flame was shown in natural colors and in motion.

The Furnace Engineering Co. had a 12,000-lb. per

hour Simplex unit pulverizer on exhibit. Recent improvements made in this type of mill include an independent motor-driven feeder and a magnetic separator to remove the tramp iron.

A recent addition to the family of unit pulverizers is the Atritor, illustrated in Fig. 3, exhibited by the Riley Stoker Corp. The machine has a primary pulverizing chamber in which the pulverizing elements consist of a series of swing hammers and a secondary chamber where the pulverization is completed by passing the coal through alternate rows of moving and stationary pegs. A more complete description of this machine will appear in an early issue. A Jones side-dump stoker equipped with power drive was also a feature of the Riley exhibit. This stoker is now available in steam- and power-driven types.

The Bethlehem Steel Co. had a model of its 6-ton mill in operation. This mill was described in the May 12 issue of *Power*.

A complete pulverized-coal installation was exhibited by the Hardinge Co. A small conical ball mill was in operation grinding river coal, the finished product being removed from the mill through a rotary classifier by air separation and discharged to a fuel bin. The classifier is a recent development of this company and replaces the auxiliary apparatus heretofore used to separate the fines and return the oversize to the mill for further grinding.

Other unit pulverizers on exhibit were those of the Aero Company and the Erie City Iron Works.

Although several of the large stoker units that have been a feature of the show in other years were not included in the stoker exhibits, hand- and power-

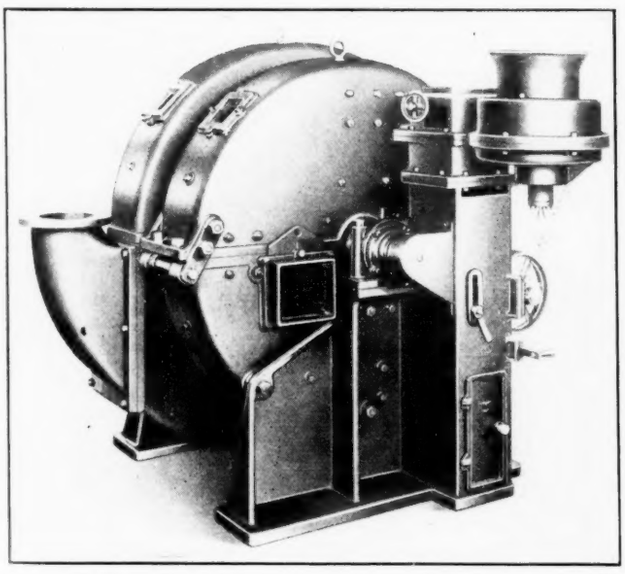


Fig. 3—Unit coal pulverizer exhibited by Riley Stoker Corp.

operated stokers were much in evidence. A standard two-retort side-dump stoker suitable for installation under a 4,000-sq.ft. boiler was shown by the Detroit Stoker Co.

A large hydraulically operated stoker, assembled complete with section of a furnace arch and side wall, was shown by Flynn-Emerich Co. This company has recently expanded its line of Huber stokers to include large sized units.

As in former years several types of oil-burning equipment were shown. The Peabody Engineering Co. had on display a combined pulverized-coal and oil burner. A circular coal chamber is inserted between the regular oil burner air register and the front of the furnace, making the burner similar in many respects to the combined gas and oil burner developed by this company about two years ago. Another recent development

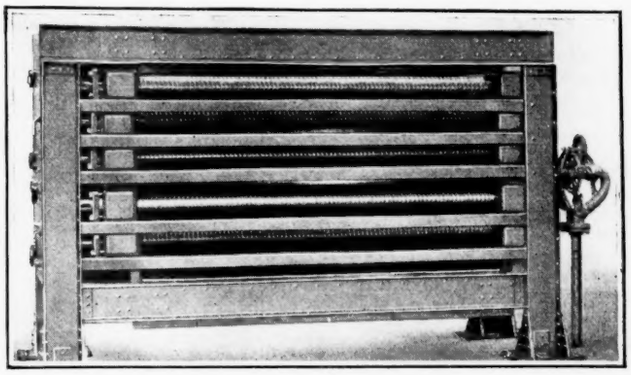


Fig. 4—Sturtevant lead-lined economizer

which was shown was a regulator for automatically controlling the viscosity of the oil supplied to the burners.

The B. F. Sturtevant Co., one of the new exhibitors at the show, had a comprehensive exhibit showing the company's products. Principal among these was an assembly of five 4-tube sections of a lead-lined economizer illustrated in Fig. 4 and an air preheater. The tubes in the economizer have extended surfaces and are lead coated inside and out to resist corrosion. The air heater, which will be described in a later issue, is designed so that the chambers are removable and reversible. Other units in the exhibit included small turbine blowers, turbine-driven multi-vane fans and a small reciprocating engine.

The Worthington Pump & Machinery Corp., also a new exhibitor at the show, had on display duplex, triplex and centrifugal pumps, air compressors and meters. As an additional feature they had on exhibit the cylinder, piston, piston rod and spray valve of their double-acting two-stroke-cycle Diesel engine after several ten-day and longer period runs totaling approximately 1,300 hours.

Centralized Systems of Combustion Control

The Engineer Co., in addition to exhibiting its standard line of boiler-draft equipment, had a working model of its new electrical system of combustion control of boiler plants. In this system the initial impulse is a change in steam pressure which is transmitted to a pressure contact switch. Closing this switch causes an increased change in the air flow to the boiler and changes the furnace pressure. This change in furnace pressure operates a draft regulator and closes a contact switch that sends an impulse to the damper regulating unit. This unit adjusts the position of the damper to maintain a nearly constant pressure over the fire and also sends an impulse to the stoker drive to change its speed to conform to the new condition. If the initial impulse does not cause a sufficient change in the air and fuel supply, other impulses are transmitted through the system until the fuel and air supply has been

adjusted to the new load conditions. The three main units in the system are the air-volume regulator, damper-controller sending unit and stoker-controller receiving unit, each of which is driven by a constant-speed non-reversing motor. The boiler can be switched from automatic to hand control or vice versa by throwing a single switch on each control unit. Any part of the equipment can be switched to hand control and the rest left on automatic regulation. Provisions are made so that adjustments can be made on any part of the apparatus while in operation.

One of the most interesting exhibits was that of the Smoot Engineering Corp., which showed a working model of the Smoot combustion control system for boiler plants, Fig. 5. It comprised a smal gas-fired boiler, arranged so that the load could be changed in steps of 75 per cent of rating from 75 to 225 per cent output in 6-min. periods. This boiler was equipped with a gas-volume, an air-volume, a damper and a stoker regulator. The latter was connected to a motor-driven electric tachometer to demonstrate how the regulator caused the stoker speed to respond to load changes. These regulators were connected to a master controller which caused the individual regulators to respond simultaneously to the load changes. A CO_2 indicator was connected into the stack, and by simple adjustments of the master regulator the quality of the products of combustion could be adjusted at will. Once the master was adjusted for a certain CO_2 content in the flue gases the regulating system would maintain this practically

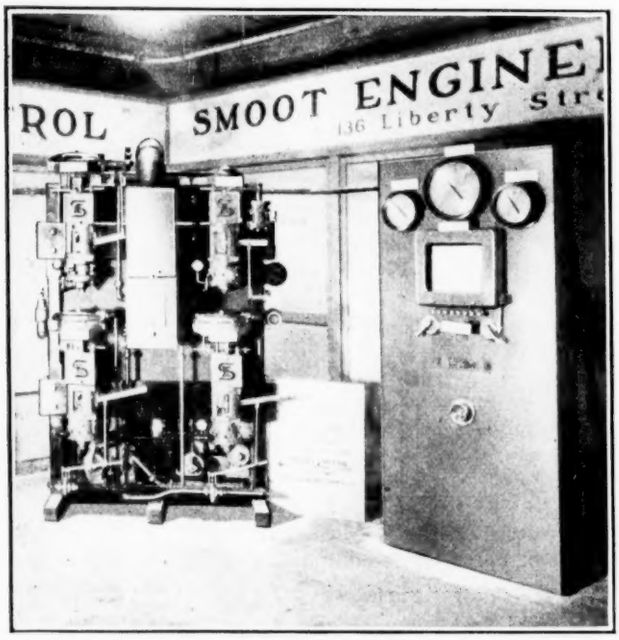


Fig. 5—Part of Smoot Engineering Corp's. exhibit of a working model of a combustion control system for boiler plants

constant over the wide changes of load. The initial impulse to operate this system is a change in steam pressure, but it was demonstrated that, over the range of from 75 to 225 per cent boiler rating, the pressure could be automatically maintained within a fraction of one pound. The equipment used on this boiler was standard such as used in a number of large boiler plants.

The Bailey Meter Co., in addition to its standard line of boiler meters and draft gages, exhibited for the first time a feeder and meter for pulverized coal, a section of a water-cooled furnace wall and a meter control for boiler furnaces based upon the well known air-flow steam-flow principle. The feeder, which is illustrated in Fig. 6 has been designed primarily to deliver and

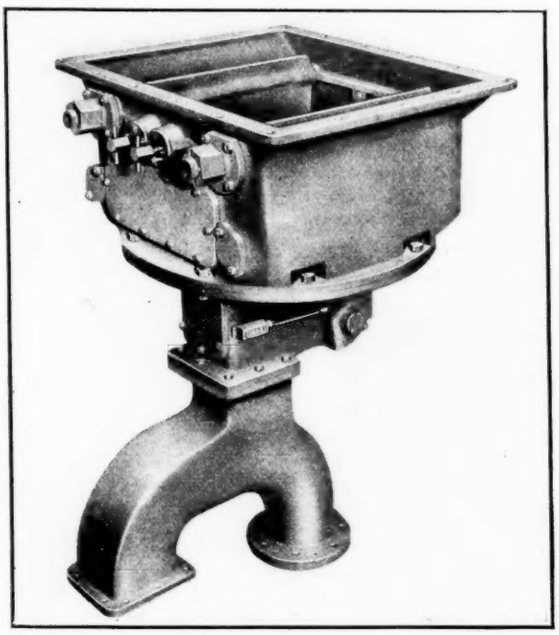


Fig. 6—Bailey pulverized-coal feeder and meter

measure coal from the storage bins to the burners. It consists essentially of a rotating distributor in the bottom of the feeder hopper, which undercuts the coal and insures a constant feed. The coal drops through an opening in the bottom of the hopper and is carried by a paddle wheel 180 deg. where it drops through an opening in a division plate to a duplicate paddle wheel and is carried another 180 deg. and discharged to the mixing tee, where it is mixed with the primary air and discharged to the burners. As the paddle wheels are designed to discharge a given weight at each revolution, a counter is attached to the feeder to record the revolutions of the wheels, and in this way the weight of coal fed over a given period can be readily determined. The water-cooled furnace wall consists of a series of 3¼-in. tubes placed 6 in. on center, to which are attached cast-iron blocks having a refractory facing composed of a large percentage of carborundum. The combustion control will be described in a later issue.

At the Hagan Corporation's exhibit a small induced-draft and forced-draft fan was operated in connection with a model furnace and conditions that exist in a boiler plant, for demonstrating how this company's regulating equipment responds to changes in steam pressure, load changes, changes in furnace draft, fuel-bed thickness, etc. A full-sized steam purifier was demonstrated, using air and water to show the principle of the apparatus and how moisture and impurities can be removed from steam, previous to leaving the boiler. There was also exhibited a de-concentrating equipment for applying the Hall system of water conditioning to boiler feed water. This machine is a specially designed combination of pump and filter, to continuously remove

a certain quantity of water from the boiler, filter and return it to the boiler. This treatment not only maintains the solids present in the boiler within reasonable limits but also eliminates the blowdown losses.

In the Carrick Engineering Co.'s mechanical type of automatic combustion control, the operation of which was demonstrated, a variation in steam pressure is transmitted through a mercury column to a master control. This controller changes the rate of coal feed and air supply to conform to the new load conditions. In the case of forced-draft stoker operation, the change would be accomplished by varying the speed of the stoker and forced-draft fan, and changing the position of the damper. To compensate for any changes in the fire conditions, a furnace regulator operates to maintain a constant pressure over the fire by adjusting the damper in the draft connection to the stoker.

This company has recently developed an electrical system of combustion control which retains the mercury U tube control of the mechanical regulator, but the impulses of load change from this are transmitted to small motors with suitable controllers that adjust the various elements in the combustion system to meet the load conditions. A working demonstration of this equipment was also exhibited.

Electrical-Equipment Exhibits

One of the large exhibits was that of the General Electric Co., which in addition to showing standard products of the company, such as steam-flow meters, direct- and alternating-current motors, small steam turbines, surface air-coolers for generators, electric measuring instruments, exhibited a new mercury-arc rectifying tube, rated at 250 amperes, for supplying direct-

Fig. 7—View down one of the main floor aisles

current to industrial loads from alternating-current circuits. Another exhibit was an improved mercury-arc battery charging set. This set is full automatic in its operation and control. When the switch on the alternating-current line is closed, the rectifying tube is automatically oscillated until the arc is established, and the battery started charging. If for any reason the alternating-current supply is interrupted while the battery is charging, the rectifier will go into service automatically as soon as the power supply is restored. On the direct-current side, the control of the battery charging is taken care of automatically, the charge tapering off as the battery approaches full charge and disconnected when the charge is completed. This makes it possible for the battery to be fully charged without an attendant, and at rates desired for charging the battery.

This company also exhibited its new synchronous motor for driving compressors, built in sizes from 20

Fig. 8—View of aisle on mezzanine

to 300 hp. This motor has a special type of starting winding in the pole faces, which allows starting the motor on full rated voltage. When started in this way the value of the inrush current to the motor is not over 300 per cent of normal full-load value on machines that run at a synchronous speed of 450 r.p.m. With slow-speed motors, the inrush current is less. This motor was fully described in the June 2 issue of this year.

Among the Westinghouse Company's exhibits was a new line of alternating- and direct-current switchboard and portable instruments. There was also exhibited a line of small steam turbines for direct-connecting or geared to electric generators, some of these for ratings as low as five kilowatts. In a line of carbon-breaker circuit breakers exhibited one had a rating of 14,000 amperes.

The equipment exhibited by the Fairbanks, Morse & Co., included a new type squirrel-cage motor, which is built in sizes of 7.5 to 50 hp. and can be connected directly across the line when starting. There are two squirrel-cage windings in separate slots on the rotor. The outer winding has comparatively small bars and high-resistance end rings, where the inner winding has large bars and end rings of low resistance. Of these two windings, the outer functions during starting chiefly and produces a high starting torque, with a comparatively low current taken from the line. During the running period the inner winding is most effective and results in the motor having a high efficiency. Another new type of motor exhibited by this company was one that is totally enclosed and forced ventilated. In the Diesel engine field the company announced its new type VA 6-cylinder two-cycle large-capacity unit.

At the Allis-Chalmers booth the exhibit included a new drive known as the "Texrope drive" for connecting motors to their loads. This drive consists of two

sheaves, one on the motor shaft and the other on the load shaft. On these sheaves run a number of endless ropes of flexible character. Some of the advantages of this drive are short centers between motor and load, silent operation, does not transmit vibration, shock absorbing and high efficiency. Although originally developed for the textile field, it is being used on many other applications.

The Louis-Allis Co. demonstrated its new speed-control system for polyphase motors. This system consists of a rotating cylinder that opens and closes contactors to cut in and out the stator windings of a multi-speed induction motor. For example, a motor wound for 1,200 and 600 r.p.m. can be made to operate at any speed between these two values by adjusting the position of the contacts or the revolving cylinder. This type of speed control was described in the Aug. 11 issue.

In the Weston Electrical Instrument Corporation's exhibit was shown waterproof electric tachometers and instruments for use in places where this equipment would be subjected to mechanical hazards and moisture. A comparison was made of the relative space occupied by a group of the company's round and square switchboard meters, the relation being 1 for the round and about 0.55 for the square type of the same rating and scale range.

A full line of electric valve-control equipment was exhibited at the Cutler-Hammer Manufacturing Co.'s

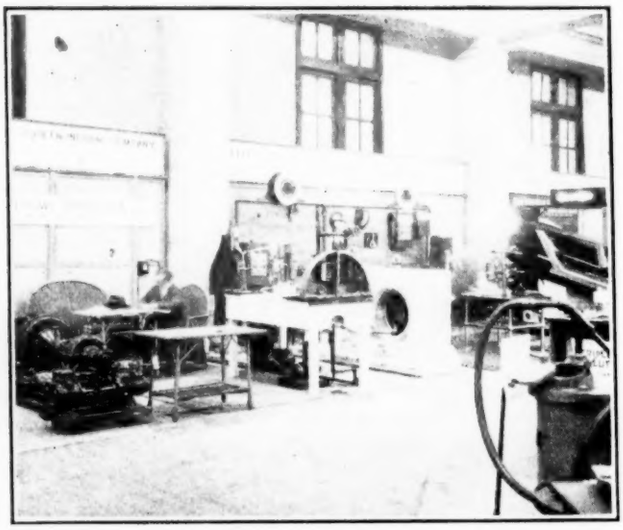


Fig. 7—View down aisle on main floor

booth. In addition to this line, there was demonstrated a new across-the-line automatic alternating-current motor starter, with thermal overload relay protection. The starter may be operated by a push button, float switch or any other means for giving the initial impulse. This starter is designed so that it is capable of successfully interrupting the stalled current of any motor within the rating of the switch. Thermal relays protect the motor against overloads and single-phase operation.

To prevent accidents on electric power circuits due to mistakes in switching, the Charles Cory & Sons, Inc., has developed and had on exhibition a system of locks for oil switches and disconnect switches, that makes it possible to operate the switches in their proper sequences only. For example, the key that unlocks the oil switch cannot be removed until the switch is open and then this key may be used to unlock the compartment doors, but removing the key from the oil switch locks the switch open. When the compartment doors are unlocked, the key cannot be removed for unlocking the oil switch until the compartment doors are properly closed and locked, so that in all cases a key is never available to allow a wrong switching operation.

Among other valve equipment on exhibition at the Coffin Valve Co.'s booth was the new type of electric valve control, known as the "Kelty unit," which completely closes the valve before the motor stops. On the closing motion of the valve there are no limit stops, but the motor is allowed to seat the valve, when a clutch slips and opens contacts that disconnect the motor. This action also comes into effect in case of an obstruction that prevents the valve from closing. On the opening operation the motor is stopped by fixed-limit switches. The operations were demonstrated on commercial units. One of the units shown was capable of developing a lifting effort of 70,000 lb. to unseat the valve if required.

A new type of electric valve control was demonstrated by the Liberty Electric Corp. This control includes a magnetic driving clutch and a multiple-disk safety clutch. On starting up, the magnetic clutch allows the motor to make several revolutions before it is connected to the valve-operating mechanism; likewise at the end of travel the clutch permits the motor to float to a stop. In case of obstructions getting into the valve when closing, the safety clutch is adjusted to slip and prevents excessive strains in the operating mechanism. This equipment was described in the Aug. 8 issue.

Air-Cooled Furnace Walls

A section of the M. H. Detrick Co.'s new-type sectional supported furnace side wall for use on furnaces of the hollow-wall type was exhibited at its booth. Each section is an independent unit supported by the furnace framework. Allowance is made for both lateral and vertical expansion, and repairs can be made to any section without interfering with any other section and without temporary support.

A new product in the form of interlocking air-cooled carborundum blocks was exhibited by the Bernitz Furnace Appliance Co. These blocks are for the same purpose as the company's standard product, but are so constructed that the outside wall of the furnace can be backed up against these blocks and yet allow free circulation of air between the two walls. These blocks are made with a tongue and groove so that they are interlocked in place.

A model of its air-cooled furnace wall was exhibited by the Liptak Fire Brick Arch Co. Vertical steel buckstays support horizontal steel channels to which heavy castings are attached to support special header blocks in the wall. The inside lining of regular firebrick is built on these blocks; in this way provision is made for expansion of the individual sections of the wall.

Air-cooled furnace walls were also exhibited by the McLeod & Henry Co. and the Waite & Davey Co., Inc.

The Carborundum Company exhibited two new products in the field of refractories. One, a new cement called "Carboplastic," and the other a gun used for applying the new cement to the interior of furnace walls. The principal ingredient in this new cement is carborundum. By the proper selection of bonding materials this cement is made to have the refractory

properties of carborundum and at the same time lend itself readily to application with a gun. The new cement is prepared for use by the addition of water to give it the proper consistency, and after being applied with the gun, air sets with a strong bond.

An interesting demonstration was made at the Quigley Furnace Specialties Co.'s booth on Hytempite firebrick cement, by heating small bricks made of this material and crushed firebrick to about 2,800 deg. F. and then plunging them into water, without any serious effects on the sample.

To demonstrate the bonding qualities of its product, "Adament Firebrick Cement," the Botfield Refractories Co., exhibited one-half of an arch supported as a cantilever beam, the cement being the only support of the brick. A new, dry, high-temperature cement, known as Key-Frax, was shown by the Keystone Refractories Co.

The Permutit Co. exhibited a model of a water softening and filtering equipment such as is used in industrial plants. This model was made exactly to scale, after the design of a large commercial unit that delivers 100,000 gal. a day. This company also exhibited a Ranarex CO_2 indicator, which was connected to a gas burner in such a way as to show how this meter responded to changes in the quality of the products of combustion. This meter was described in the Feb. 17, 1925, issue.

Enclosed-Type Centrifuge

A totally inclosed type of centrifuge known as the "Presurtite" was exhibited by the Sharples Specialty Co. This unit is used for centrifuging heavy oils such as the heavier Diesel fuels, without the escape of dangerous or objectionable vapors, when the temperature of the oil is increased sufficiently to obtain the most efficient clarification. This machine is totally inclosed, both the oil feed and discharge being piped to and from the machine and any vapors that may be released within the casing can be piped to the outside of the building for disposal.

At the Cork Foundation Co.'s booth there was in operation a motor-driven compressor to demonstrate the shock-absorbing effects of the company's new product, consisting of plates of natural cork, known as "Absorbo," when placed under machinery foundations. This material is made from strips of specially selected cork 1½ in. thick, set in steel frames and impregnated with creosote to render it impervious to oil and water.

The Nash Co., manufacturer of sewage ejector systems, return-line pumping units, showed as an additional feature a 2,000-cu.ft. per min. compressor direct connected to a synchronous motor.

The Dahl-Bethlehem oil-burning equipment and several types of turbine-driven and reciprocating boiler-feed pumps were shown by the Bethlehem Shipbuilding Corp.

The Wheeler Condenser & Engineering Co. had a section of an atmospheric cooling tower in operation to show the distribution of water within the tower. Sections of high-pressure evaporators and two-stage centrifugal pumps were also shown.

A working model of a complete hydro-jet ash-handling system was shown in operation by the Allen-Sherman-Hoff Co. This system includes an arrangement of jets for feeding the ashes from the hopper below the stoker, to the sluice, a horizontal sluice in which the ashes are carried along to a sump by water injected through nozzles, and a centrifugal pump for handling the ashes from the sump to the car-loading hopper.

The Power Specialty Co. had on exhibit a section of a superheater header showing the extruded-neck-type nozzle in which the header metal is rolled in a serrated flange and then welded. Sections of radiant and convection type elements were also shown.

Under the general headings of power-plant specialties or accessories, many new developments were to be found. A new departure in soot-blowing systems was exhibited by the Diamond Power Specialty Co. The

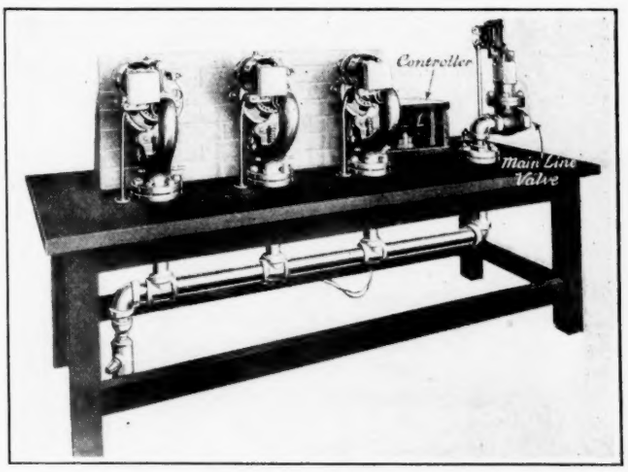


Fig. 8—Diamond electrically operated soot blower

system, illustrated in Fig. 8, comprised an electrically operated main-line steam valve, three motor-driven heads and a master controller for controlling the operation of the valve and the blower heads. An automatic drain valve is connected to the end of the steam header from which the branches are led to the individual units. This valve remains open when the pressure is off the header, but closes automatically when the pressure is turned on. Additional blower elements made of Dialoy metal, designed especially for service in abnormally hot positions, were also shown.

The trap shown in Fig. 9, in which a Corliss type of valve and a non-collapsible or balanced pressure float are used, was exhibited by the Sweet & Doyle Foundry & Machine Co. The float is made non-collapsible through the equalization of pressures inside and outside of the float by means of an equalizing tube. The tube opening at the top of the float is hooded to prevent water infiltration. The drainage tube is connected through the float spud to the hollow valve lever and in the open or closed position is connected through ports in the valve with the discharge line, so that any moisture that may tend to gather in the float is readily discharged.

A safety stop for steam engines, turbines and pressure lines, designed to prevent engine overspeeds and damage to the unit from water coming over with the steam, was shown by the Ludeman Bros., Inc. A specially designed throttle valve with an auxiliary control valve is employed. The valve is connected to the separator in the line in such a way that an accumulation of water in the separator causes sufficient difference in pressure to open the auxiliary valve and admit steam to a small cylinder and piston, which in turn closes the stop valve. A further description will be given in an early issue.

Two sections of an Elesco superheater for a 15,000-sq.ft. boiler of the Illinois Power & Light Co. were on display in the booth of the Superheater Co., the tube in each section being approximately 80 ft. in length.

R. H. Beaumont & Co. had a model of a skip hoist with simplex loader and tail car in operation, sections of cast-iron sluice and hand and hydraulically operated ash gates were also shown.

Types of rado-jet air pumps and turbine-driven centrifugal pumps were exhibited by the C. H. Wheeler Manufacturing Co. A low-pressure rado-jet augmenter designed for improving the vacuum obtained with wet-air pumps and an absorption dynamometer of the Groude hydraulic type was also shown.

The Reilly type of evaporator and heater and a bent-

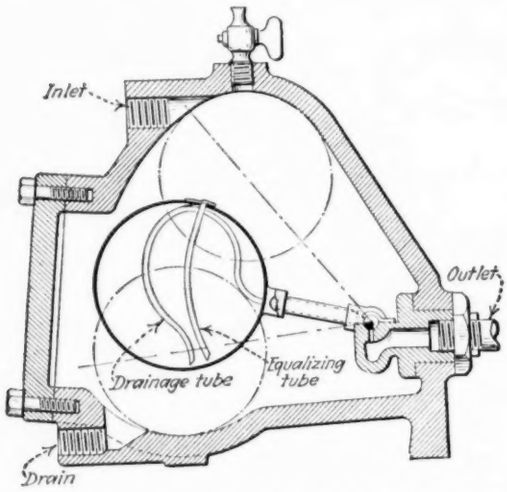


Fig. 9—Steam trap with balanced pressure float

tube type evaporator and a multi-whirl cooler were shown by the Griscom-Russell Co.

Several types of soot blower heads were exhibited by the Mayer Co., as were also a double-tube air-cooled element and a single Monel melted sheathed element.

A water-level indicator designed to indicate the level in the boiler at any convenient location and at as many places as desired was exhibited by the W. B. Connor, Inc. The indicator consists of a water column of special design connected to the boiler at the usual level and containing a guided float which actuates the indicating device. The indicating panel, which can be located at any convenient point consists of a series of pilot lamps, the center one indicating the normal water level and the other a corresponding high or low level.

In addition to its standard line of feed-water filters and strainers the Blackburn-Smith Co. showed an improved type of centrifugal pump primer and the complete line of Sherwood specialties, including injectors, ejectors, lubricators and oil pumps.

A special feature of the exhibit of the Uehling Instrument Co. was a new waste meter which makes a record of the CO_2 and flue gas temperature on the same chart. A description of this meter will appear in an early issue.

In addition to its regular line of feed-water regulators and pump governors the Northern Equipment Co. showed a thermostat element designed for 300 lb. and above, for use on the Copes regulator in high-pressure service.

A "tracyfier" designed to remove the dirt and moisture from the steam before leaving the boiler was exhibited by Andrews-Bradshaw Co. It consists essentially of a cast-iron frame semi-circular in shape on the upper side to conform to the drum and containing a series of U-shaped vertical baffles, placed in zigzag formation.

Several types of centrifugal steam purifiers were exhibited by the Centrifix Corp. These units are now being made in both single and multiple types, the latter being developed especially for large boilers operating at high ratings. Certain types of the purifiers are made of all Monel metal and are adaptable to both high- and low-pressure boilers.

A type of feed-water regulator controlled directly from the level of the water in the water column was shown by the Campbell Engineering Co. The regulator has no floats or thermostats and is made to open or close as either steam or water is admitted to a pipe connected between the column and a control valve, the inlet end of the pipe being at the normal water level in the column.

A pressure regulator equipped with a separate strainer and auxiliary control valve which can be placed in any convenient location, independent of the main valve, was exhibited by the Spence Engineering Co. A further description of this valve will appear in an early issue.

The Edgemoor Iron Co. had on exhibit drawings and photographs of its single-pass boiler installation at Binghamton, also drawings showing design and constructional features of the horizontal-drum and cross-drum water-tube boiler. A description of the single-pass boiler appeared in the Nov. 13, 1923, issue.

Sections of the oval-tube generator air cooler and a new flat spray nozzle were included in the exhibit of the Schutte & Koerting Co. A toggle-top stop and check valve and single- and multi-jet condensers were also shown.

High-Pressure Blowoff Valves

The Yarnall-Waring Co. exhibited its line of blowoff valves, spray nozzles, weir meters and recorders. The tandem arrangement of balanced seatless valves for blowoff service where the pressure runs from 300 to 800 lb., featured.

The Pennsylvania Crusher Co. had a small armor-plate crusher suitable for laboratory use, in operation. This crusher was described in the April 7 issue. A model of a Bradford breaker was also shown.

In addition to its standard line of specialties the Crosby Steam Gage & Valve Co. had on exhibit a new type of safety valve designed especially for high pressures. This valve will be given further mention in an early issue.

The Cooling Tower Co. exhibited its "Tang L. Dust" air filter, together with cleaning and charging tanks, also a combination nozzle and strainer for air washer. The filter is made up in units that can be grouped together to suit installation requirements.

An extended funnel ferrule designed to eliminate the erosion at the ends of condenser tubes and also give a greater depth of packing, was exhibited by the Crane Packing Co. This ferrule is screwed into the tube sheet and the packing is placed between the ferrule and the tube, the packing depth being from 1 to 1½ in.

The De Laval Separator Co. had an extensive exhibit of oil-purifying apparatus. A portable unit for transformer and switch oils, equipped with conservator

attachment for use with the conservator-type transformer, was shown. This attachment permits the oil to be passed through the machine and returned to the tank without coming in contact with air. A motor-driven purifier, having a capacity of 1,000 gal. an hour and a standard machine equipped with vapor-tight corners of cast aluminum, were also shown.

A recent addition to the line of sectional air filters was shown by the Spray Engineering Co. The cells that contain the filtering media are supported in a sectional framework and sealed against air leakage.

The exhibit of Warren Webster & Co. featured a modulation heating system in operation, the system shown being applicable to buildings requiring from 500 to 32,000 sq.ft. of direct radiation. An illuminated radiator was used to show the principle of the modulation system of steam heating and the operation of the modulation valve.

The Heine Boiler Co. had on display a full-sized forged steel header used in its cross-drum boilers. Photographs and drawings of recent installations were also on exhibit.

A pump that can be used for vacuum or pressure service and can be operated in either direction without physical change was exhibited by the American Machine & Foundry Co. A description of this pump appeared in the Nov. 13 issue.

A new type of oil engine was exhibited by the Crankless Engine Co. This machine employs a swash or wabble plate keyed to the shaft at an acute angle. The cylinders are placed parallel to the shaft, and the pistons, which are in pairs, bear against the wabble plate through a special type of thrust bearing. Combustion in the cylinder reacts on the piston and wabble plate, and the component of the thrust tangential to the shaft causes the latter to rotate. Owing to the special bearings the friction losses are low. The principle was fully covered in *Power*, Oct. 2, 1923. The crankless machine shown employs high compression, using oil for fuel, and is adaptable to marine and vehicular drives. (See Fig. 10.)

Valves and Fittings

Chapman Valve Manufacturing Co. exhibited for the first time a high-temperature outfit for long-time duration tests of metals under elevated temperatures and constant load. During the show abbreviated tests were being run on cast chrome nickel steel at 1,000 deg. F. with loadings of 11,000 and 16,000 lb. per sq.in. Various types and sizes of valves in accord with the late standards and a special line of high-pressure fittings were on display.

Pittsburgh Valve, Foundry & Construction Co. displayed a number of their recent valves; one 6-in. 600-lb. W. S. P. equipped with a Liberty valve operator, an 8-in. 350 lb. valve fitted with Dean control and a 6-in. 400 lb. non-return valve. The valves first named were so arranged that the motor may be set at any angle. Other items of interest were various exhibits of welding and of valve construction.

The Edwards Valve & Manufacturing Co. showed, in addition to its usual non-return stop, blowoff and feed-line valves primarily designed for plants operating at high pressures and temperatures, a new type of "Ferac" non-return valve, with new features of construction such as forged-steel yoke posts and forged bronze cross yoke, and their latest development in a high-pressure packless "Tube" blowoff valve.

At the Ashton Valve Co.'s booth outstanding features were an improved master pilot type of pressure gage, with double illuminated 30-in. dials and a hand adapter by which the gage can be recalibrated without taking off the indicator hand, and an improved double-area dead weight gage tester along with the regular line of pop safety valves, relief valves and pressure and vacuum gages.

Reading Steel Casting Co. had on exhibit a new line of bronze "Reduro" union-bonneted regrinding bronze globe valves with renewable disk and seat ring of Swift metal for moderate pressures. To withstand severe throttling duty the disk has a spiral throttle lip. Other exhibits were a complete line of cast-steel fittings for the new standards from 250 to 900 lb., a lighter line of fittings for 150 lb. and a typical valve display.

Crane Co. had an interesting display of 400-lb. valves of the motor-operated stop-check type, an emergency stop valve electrically operated and a 10-in. cast-steel valve with the Crane electric control, in addition to a complete line of cast-steel gate valves in accord with late standards for pressures from 150 to 900 lb.

Manning, Maxwell & Moore, Inc., featured the improved line of Consolidated safety valves which are now ready for all pressures up to 1,200 lb., as recently described in these columns. Other specialties exhibited were Hancock high-pressure bronze and steel globe, angle, gate, check and blowoff valves and a new drumhead stop and check valve for pressures up to 1,200 lb.

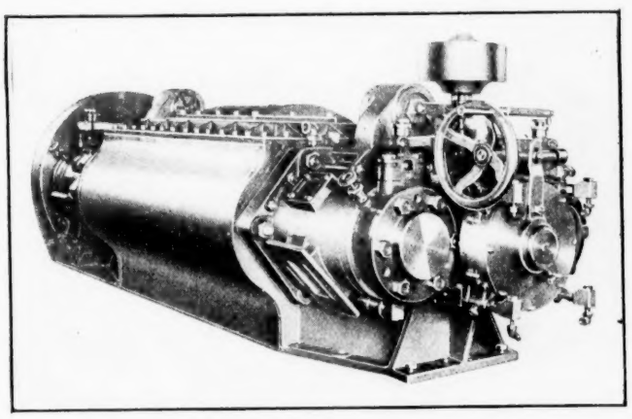


Fig. 10—Four cylinder crankless engine

Jenkins Bros. featured a new line of medium pressure bronze globe and angle valves with renewable disks for 225 lb. working steam pressure. An unusual feature of this valve is the bonnet and union made in one piece to screw onto the outside of the body threads. This valve is shown in Fig. 12.

In an exhibit of valves for many uses the Everlasting Valve Company featured as a late development a high-pressure rising-stem outside-screw-and-yoke "Looseat" gate valve with a sliding, rotating disk, so designed that both seat and disk can be removed without the use of tools.

Comparatively new specialties featured by the Foster Engineering Co. were a toggle lever type of non-return valve, a new type of pressure reducing valve with a ground seat auxiliary valve instead of a disk and with both main and auxiliary valves inclosed by strainers, a new pressure reducing valve controlled by vacuum and a new pump governor for low-pressure oil pumps.

New developments at the Lunkenheimer Co. booth were four types of valves: one a 30-in. reheat valve which ranks with the largest cast-steel valves ever made for 250 lb. pressure; an all Monel gate valve made in ½ and ¾ in. sizes for pressures of 400 lb. and a maximum temperature of 750 deg. F.; a complete line of cast-steel swing check valves Monel mounted for pressures of 400, 600 and 900 lb. W. S. P. and in sizes from 1½- to 10-in. and an extra-heavy cast-iron bronze-mounted gate valve representative of a complete new line in sizes from 2 to 24 in. and for pressures of 125 and 250 lb. W. S. P.

Mason Regulator Co. showed in addition to standard bronze and iron body valves a new cast-steel high-lift valve developed for controlling the higher pressures, pump governors of the pressure and speed-control types and a great variety of other steam specialties.

New products exhibited by the William Powell Co. were a cast-steel gate valve, Monel metal trimmed and electrically operated, for high pressures and superheats; a quick-acting valve, lever operated against a spring, for laundry work and general steam purposes, which opens and closes quickly, and a line of valves cast completely of Monel metal.

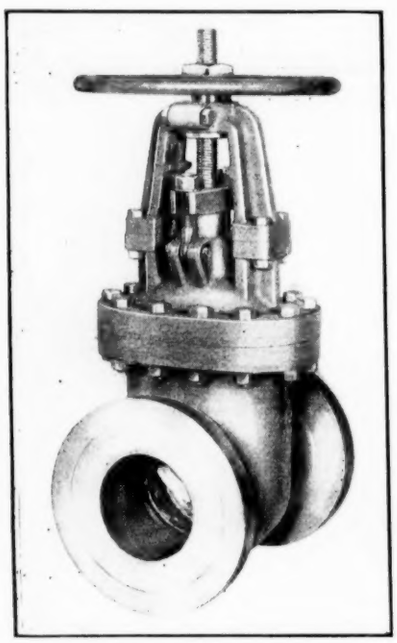


Fig. 11—New type of extra-heavy gate valve

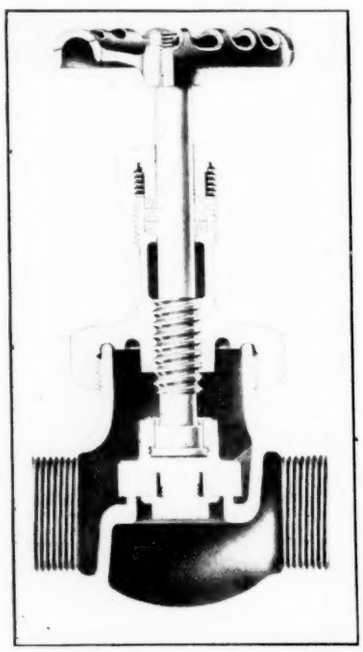


Fig. 12—A 225-lb. valve with renewable disk

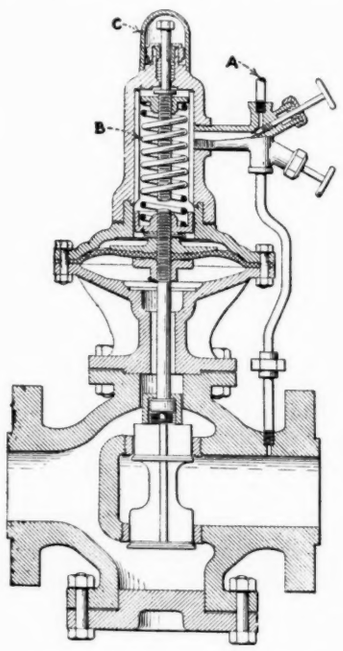


Fig. 13—Valve to control excess pressure on feed line

High-Pressure Plug Valves

A new refinery type of valve for high temperatures and pressures with a straight round passage, when the valve is open, of the same diameter as the pipe, was featured by the Homestead Valve & Manufacturing Co. Plug type valves for services up to 1,000 deg. F. and the regular lines of globe, plug, blowoff and hydraulic valves were shown and a working model with glass fronts was on exhibition to show the difference between the operation of valves with and without the protected seat feature used by this company.

The D. T. Williams Valve Co. featured an exhibit of "Reverso" and "Iroverso" globe, angle and check valves with reversible, regrindable and renewable nickel-alloy disks and seats for pressures of 150, 200 and 300 lb. and maximum temperatures of 450 and 550 deg. F., in addition to complete lines of bronze and iron gate valves, lubricators and other specialties.

The Barco Manufacturing Co. featured their lubricated plug valve which is of the inverted type so that the plug cannot blow out from the breakage of a gland, and their flexible ball joints for industrial use.

Exhibits of the Hydraulic Press Manufacturing Co. were the new "Forgsteel" globe valves and three-way slide operating valve for cold water and steam, a line of high-pressure hydraulic valves and a complete display of drop-forged steel valves and fittings for high pressures and temperatures.

A working model of an electrically operated motor-driven step-action regulator for operating a panel serving motor-driven auxiliaries was the leading attraction offered by the Ruggles-Klingemann Manufacturing Co. Among the other products shown were adjustable fulcrum, high-lift balanced valves, pilot-operated "Uniseat" regulating and reducing valves, reversible motor pressure controllers for the regulation of any pressure from vacuum to 1,200 lb. and electric motor-operated valves for remote control.

The exhibits of the Techno-Service Corporation which were much the same as a year ago, consisted of a 14-in. Borsig valve with Dean control, an 8-in. Borsig valve with Cory control, a crushed model of the valve to show the physical properties of the cast-steel and an exhibit of a single-acting, plunger "Kobra" pump with a ball valve for ash and sludge removal or for handling heavy liquids, equipped for electric or gasoline motor drive.

The Merco Nordstrom Valve Co., Inc., featured a 16-in. plug cock which is probably the largest of its kind ever manufactured. These large sized valves, are being used in high-pressure illuminating gas lines. In addition there were improved types of three- and four-way plug cocks used principally on air lines.

In addition to the regular lines of drop-forged steel

valves and fittings the Henry Vogt Machine Co. was showing a new combination horizontal and vertical ball check valve with flanged ends for pressures up to 650 lb. and temperatures to 1,100 deg. F. and the same type of valve in the smaller sizes with screwed ends.

Standard lines of forged steel unions, fittings, plugs, couplings and bushings were exhibited by the Continental Valve & Equipment Co. Blueprints showed new designs of pump governor and reducing valve.

Gages, Meters and Instruments

Lewis M. Ellison had in an excellent display of draft and air pressure gages, steam calorimeters and the Ellison-Leach gas analyzer, a new line of differential gages to show the resistance through air filters and air preheaters. A feature of unusual interest and value was a new leakproof cement that has withstood kerosene under pressures exceeding 100 lb.

Besides showing a new mercury recording thermometer with fully compensated capillary tubing which eliminates error for temperature differences along the connecting tube, the C. J. Tagliabue Manufacturing Co. featured the "Tag Hespe" tube on mercury thermometers, which with its red backing in the bore, is easy to read, and in addition showed the usual line of indicating, recording and controlling instruments.

In the Bristol Co.'s booth an interesting exhibit was the new Bristol-Derr water level gage made to indicate or record the water level in steam boilers. In a large display of flush-front indicating and recording gages and clocks, one of the newest instruments was a fast-moving strip-chart voltmeter for recording line surges. This same quick-moving chart is furnished in ammeters for connection to the neutral circuit of generators.

Along with a variety of standard meters the Republic Flow Meters Co. showed for the first time the new motor-driven CO_2 recorder which eliminates the difficulties previously experienced with bad water as an operating medium, the multiple-draft indicator giving all readings at one eye level, and the liquid level indicator and recorder equipped with electric control to regulate the height of water in storage.

The Paul B. Huyette Co. showed in addition to the usual lines, some Hays specialties including the improved CO_2 and draft recorder; a $\frac{1}{2}$-in. differential draft gage with sliding scale, that can be carried in the pocket with the oil in it, and two new pointer draft gages, one having a single diaphragm that can be adjusted for any desired scale reading and the other equipped with a balanced hollow tube using heavy oil to indicate the draft.

An attractive display of power-plant instruments was to be seen in the space of the American Schaeffer & Budenberg Corp., including indicating and recording gages and thermometers, pop safety and relief valves, tachometers, counters, calorimeters, gage testers, Columbia round form recording gages and thermometers, a new universal dial thermometer and a new mercury actuated temperature controller for all temperatures up to 1,000 deg. F.

Cochrane Corporation featured a strainless conical filter filled with three grades of gravel and one of sand, which was connected to a working exhibit consisting of a centrifugal pump circulating water through a V-notch meter and a pipe orifice connected to three Cochrane flow meters of the tilting manometer type. In addition a new combined flow meter and temperature and pressure recorder was shown, also separators, steam traps or drainers of two forms and a multiport back-pressure valve.

A complete line of power-plant instruments formed the exhibit of the Brown Instrument Co. New features were new model continuous chart recorders for temperature and CO_2 measurements in which the mechanical parts are driven by electric clocks, a new illuminated dial CO_2 and flue-gas indicator, water cooling for the CO_2 cell unit and a liquid level water gage in which the usual diaphragm has been replaced by a bell element kept filled with air which is located at the bottom of the tank and transmits the reading according to the head of water.

In the space of the Foxboro Co., Inc., the new feature was a differential pressure type liquid level gage for the measurement of liquids in containers under pressure, particularly large high-pressure boilers, pressure-type kilns, etc. Other new features were an averaging bulb for flue gas records and a chart hub for recording instruments by means of which the chart can be adjusted by turning a knurled nut. In the gage display it was interesting to compare the first recording gage made in 1908 and the latest development in this line.

In the display of the Taylor Instrument Companies an attractive new instrument was the direct-reading superheat indicator or thermometer which has an auxiliary scale that can be moved up and down by means of a rack and pinion operated by a knurled nut. The thermometer is scaled on the left-hand side with a temperature scale and on the right-hand side with a corresponding steam pressure scale. The zero of the adjustable scale is set opposite the steam pressure and the superheat is the reading opposite that of the temperature scale. Other new developments were a long distance transmitting recording thermometer, a mercurial type pyrometer and a barometric type mercury column vacuum gage with vernier scale and thermometer, the vernier making it possible to read the vacuum to 0.01 in.

In an attractive exhibit of expansion joints the American District Steam Co. featured the duplex-sleeve joint made for high pressure and superheated steam. Several types of underground steam line construction showing actual methods for high- and low-pressure steam were on display, also simplex and rotary condensation meters, the St. Johns steam meter with a new integrating device, standard pressure guided joints and numerous heating specialties for the Adsco system of atmospheric steam heating.

Instruments for electrically measuring temperatures and CO_2 formed the exhibit of Charles Engelhard, Inc. The temperature measuring instruments included electric resistance thermometers of the platinum quartz type operating in conjunction with switchboard recorders and special portable testing sets. The recorders, which were equipped with automatic rewinding charts printed by means of typewriter ribbon, were made in single and multi-point types up to six point, six color. Other items of interest were thermo-electric pyrometers, CO_2 recorders of the electric thermal conductivity type and a thermoelectric indication station for eighteen temperatures.

Builders Iron Foundry had a comprehensive exhibit including a working model of the Venturi tube with the registering, indicating and recording instrument, a Warren electric clock movement recently developed, a cast-steel Venturi meter tube for use on pressures up to 1,000 lb. per sq.in., a Venturi nozzle and boiler

load indicator for the measurement of steam, an improved planimeter for totaling Venturi meter charts, and for refrigerating work a Venturi ammonia meter and a 2-in. Venturi tube with special oil seals and an indicating manometer specially designed to check the efficiency of compressors and the proper setting of expansion valves.

The E. Vernon Hill Co. showed a new line of air test cases for heating and ventilating engineers, a line of pitot tube and draft gages for various purposes and the "Caliscope" of the American Temperature Indicating Company.

The Federal Gauge Co. showed a new line of oil burner safety devices in addition to a variety of Mercoid switches for various purposes, float and pressure switches, steam gages and an industrial type instrument for temperature and pressure regulation with adjustments for operating differential and operating point.

The Moto Meter Co., Inc., had a full line of industrial thermometers covering ranges from 40 to 750 deg. F. None of the instruments were new, but a number of improvements had been made in construction and in materials, adding to the strength and durability of existing instruments.

Regulators and Miscellaneous Specialties

In a general exhibit including section models and samples of the various types of Curtis pressure-reducing valves, steam traps and automatic damper regulators, the Julian D'Este Co. displayed as new specialties a type of steam regulator of which the valve body need not be removed from the pipe line when making repairs, and a spring-operated domestic water regulator in which the diaphragm and seat may be removed without taking the regulator out of the line.

Mercon regulators of three different types, consisting of the constant back-pressure regulator, the constant reduced-pressure regulator and the excess-pressure regulator for boiler-feed pumps made up the working exhibit of the D. H. Skeen & Co., Chicago. The last-named type is used also as a differential regulator to maintain a constant drop across a fixed orifice. It will be recalled that all these regulators use a mercury column in place of a spring or weight to balance a diaphragm against the pressure in the regulator that is to be governed.

For remote control of liquid levels in tanks the Fisher Governor Co. showed two types of regulator, one pilot-operated and the other a liquid-transmission type of control; also a new vacuum regulator, a new patented system of control piping for measuring liquids volumetrically, a new type of water-operated pilot-controlled pressure regulator for service as a master control in pressure-regulating work and a new series of steel-bodied Monel-trimmed boiler-feed excess-pressure governors designed for high pressures and temperatures.

The Fulton Company had on display a great variety of Sylphon specialties, including a liquid-transmission air-duct thermostat used to control the supply of steam to heating coils by the temperature of the air passing through the air ducts. A hot and cold water mixer for industrial application where a given temperature of water is received was of interest, and the same may be said of a new Sylphon regulator for controlling the steam supply to open tanks and the quantity of brine to cooling coils in refrigerating work.

A "Junior" boiler feeder for controlling of the water level in boilers, a stage heater safety unit for the automatic control of oil and gas separators, gas lines and safety shutoffs, and float valves for controlling the water level in tanks were the features of the G. M. Davis Regulator Co. exhibit. The regular products also were in evidence, such as pressure regulators, back-pressure valves, automatic stop and check non-return valves, combination, back-pressure and relief valves and hydro-control regulators.

Besides showing its usual line of engine-stop and speed-limit systems and numerous steam specialties, the Locke Regulator Co. featured a damper regulator improved by a guard supporting the lever on the pressure cap to prevent it from getting misplaced.

In addition to displaying regular lines of steam specialties including damper regulators, balanced valves and an auxiliary pressure regulator, the Watts Regulator Co. distributed some valuable flow charts showing the capacities of Watts reducing valves and the flow of steam through pipes.

Two new regulators were placed on exhibition by the Atwood & Morrill Co.; one an adjustable combination regulator for pressure stoker reduction, unloading, fan and damper control, and the other an adjustable step and stop boiler-pressure regulator. Included in a general line of steam specialties were a number of new bleeder valves for low-pressure turbine bleeding and condensate trap and float chambers.

Elliott Company and the associated companies showed a representative line of products, including a two-stage Kerr turbine for auxiliary drive; a building type deaërator of 750 gal. per hour capacity; a new "Welderon" receiver separator made of hammer-welded pipe with no longitudinal seams and all joints electrically welded, featured by a solid through pipe to eliminate expansion and contraction strains from the pipe line; a streamline-flow non-return valve for high pressures and superheats, an exhibit illustrating the three types of steam-jet air-ejecting equipment and a new air-driven Liberty surface cleaner.

Steam Accumulator System

Considerable interest was shown in the exhibit of the Ruths Accumulator Co. A model of a typical accumulator installation was shown with connecting steam lines and valves. Two of the full-sized standard controlling valves used with the accumulator system were also shown.

A feature of the exhibit of the A. W. Cash Co. was a master controller recently developed. The power cylinder of the controller is hydraulically operated, the piston diameter being 6 in. with a 12-in. stroke. Although designed for use with the Craig system of automatic combustion control, the regulator is adaptable to the regulation of forced-draft fans, stokers and dampers.

The Crane Co. exhibited a new type of bellows packless radiator supply valve, together with its standard line of steam specialties and motor-driven return line vacuum pumps.

A furnace fire observer was exhibited by the Vastine Engineering Co. The observer, which consists of an air-cooled cast-iron frame containing a window in which is set a pane of blue and a pane of white glass, is installed in the furnace door or mounted in the furnace wall. By means of this observer practically all the fuel bed can be observed at any time without the necessity of opening a furnace door. A description of this device appeared in the Jan. 13 issue.

The Fellowship of Power

IT IS good to be in the power game. Each meeting of the A.S.M.E. drives this thought home. The power man, of whatever industry, unhampered by the restrictions limiting the process man, is able to talk freely of his work and methods.

Each man is glad to tell of his successes, and many are willing to disclose their less ridiculous failures. The more able and experienced cheerfully give of their mastery to the man whose advantages have been less in either duration or intensity.

The benefits of such free interchange of ideas, however, come only to those who keep in touch with the power world through personal contact or the printed page. Every power man who takes pride in his work, who is glad to be called an engineer, should ally himself with others in the same work, through membership in the national society of his choice.

Physical Chemistry in the Power Plant

CHANGES in the art of power plant operation are placing new demands for further education and training on the operating engineers. Twenty-five years ago operating engineers devoted their time to studies of the steam engine indicator and its diagrams as a means of securing economical setting of the valves of the main engine. Next came improvements in the boiler house with stokers and CO_2 recorders and other devices whose theory and operation must be studied.

Probably the greatest need of additional study was felt when the steam turbine became an established prime mover. The engineer had to study not only the turbine, but condensers and high vacuum. Further improvements in boilers, stokers, superheaters, air preheater, heat-balance equipment and miscellaneous auxiliaries including electrical drive for these auxiliaries, have made it necessary for the operating man who would stay up to date, to burn much midnight oil in an attempt to keep in touch with progress.

It is becoming apparent that a knowledge of physical chemistry would be of great assistance to power-plant operators. He could then study his furnace to better advantage. Combustion reactions could be fully understood, radiation phenomena and heat absorption would be less of a mystery; evaporation and heat transfer phenomena would offer few difficulties; fewer mistakes would be made in the drying of coals; if coal distillation becomes a part of the central station, the reactions in the coking process can be analyzed while the fundamentals of hydrogenation of coal or byproducts may at least be known. The ageing of oils, and other phenomena that prove so troublesome and hard to comprehend, also fall within the province of physical chemistry.

If one could get a writer like Sir Oliver Lodge to outline in his simple and delightful way the laws of physical chemistry as applied to power-house problems, he would have the sincere thanks of an army of operators who feel the need of more enlightenment on these various subjects. Till such a work is forthcoming, the engineer must delve through articles in the technical press or attend meetings where he gleans fragments of information that he must adapt and apply to his own peculiar conditions.

The Journeyman Engineer

TOO MANY young engineers have been impressed with the proverb of the rolling stone gathering no moss and have become fixtures in the plants where they found their first jobs. This is a mistake, for nothing broadens one as much as the facing of new problems in new situations.

In the old days of the metal craftsman the custom was for the young machinist, upon completing his apprenticeship, to seek work in another shop. Being young and eager to see the world, the ex-apprentice turned his steps to other states, often working but a few weeks before leaving the new-found job for a chance at another one. Thus was created the term *journeyman*, which carried with it the idea that the workman had worked in enough shops to have become well grounded in the basic principles of his craft, even though he lacked that experience possessed by older workmen.

The custom, still practiced to some extent in the railway shops, had its merits. The youngster can gain only a limited amount of knowledge in a single shop, but the journeying from job to job gives the experience needed to make a well-rounded mechanic.

Power plants seldom have a distinct course of training by which boys are trained to become engineers. Many, however, do take in young inexperienced men to fill minor positions and by a gradual process of training fit them for progressive jobs of fireman, oiler and watch engineer.

Unfortunately, the tendency is for the young man promoted to the position of watch engineer to stay in the old plant. His chance of promotion may be thereby heightened, but the opportunity to broaden his knowledge of power plant engineering is, at the same time, limited by the data possessed by his superior, supplemented by reading of engineering literature.

While not advising traveling when actuated by a mere wanderlust, in the majority of cases it would profit the ambitious to seek his luck in another plant. With a whole lifetime before one in which to correct a mistake or, if need be, to back-track, one should not hesitate to take a chance. If one's present job seems limited as to its possibilities, it is good business to seek elsewhere.

Higher Steam Pressures for Industrial Plants

IN THE last three years steam pressures for central stations have swept upward with astonishing rapidity. The movement is still in full swing, but with a present tendency to pause for a while at pressures in the neighborhood of five hundred pounds as giving the greatest commercial economy for base-load plants using fairly expensive fuel.

As has been pointed out editorially by *Power* from time to time during these three years, the industrial plant is on the whole a more logical field than the central station for high-pressure developments. This same view was put forward and ably developed by William F. Ryan, chief engineer of the Solvay Process Company, Syracuse, New York, in a paper presented at the recent annual meeting of the A.S.M.E.

As Mr. Ryan there pointed out, the percentage gain from increased steam pressure is least for high-vacuum plants, in which class most central stations fall. Lack of condensing water forces the average industrial plant to operate with low vacuum, or more frequently with none at all. Even where no steam is used for process or heating in such plants a given increase in steam pressure will save a larger percentage of the coal bill than in high-vacuum stations.

Now consider the case of a non-condensing industrial plant where steam at atmospheric pressure or higher is required for process and heating. At any given moment one of three conditions must exist: The power exhaust will exactly equal the heating requirements, it will exceed them, or it will fall short. The case of exact equality may be eliminated as of too rare occurrence to be important. The effect of increased steam pressures on the other two is of interest.

When the present power exhaust exceeds the demand for exhaust steam, increased steam pressures will greatly reduce this excess and may do away with it altogether. Coal is saved equivalent to the reduction in steam blown to waste. When the engine exhaust falls short of the process demand, increased pressure has no effect on the total coal bill.

The practical ideal to be approached is an efficient prime mover operated at a sufficiently high pressure to generate the required power, most of the time at least, with less steam than is needed for process.

The day is probably not far off when many industrial plants will be operating on steam pressures of five hundred or six hundred pounds. There are doubtless some plants where a combination of high back pressure and relatively large power demand may justify pressures up to one thousand pounds or more.

Combining Power and Heating Loads

DURING this year the production of a kilowatt-hour on less than fourteen thousand heat units was hailed as an achievement of no small importance. Comparing this with the best practice of twenty years ago, when thirty-five thousand heat units were required per kilowatt-hour, indicates that noteworthy progress has been made in steam power-plant efficiency. When this year's accomplishment is measured in the over-all thermal efficiency of the plant, it is found that less than twenty-five per cent of the heat units delivered to the boilers and furnaces are accounted for on the bus-bars. A large part of the difference is thrown away in the condensing water. The possibilities of doing much better than twenty-five over-all thermal efficiency in a condensing steam plant, does not offer anything very promising.

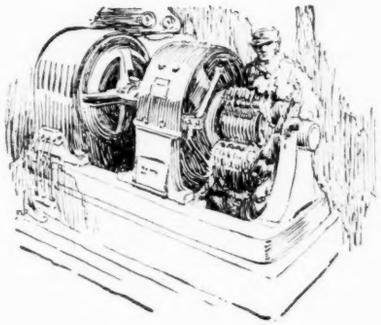
If some way can be worked out to combine central heating and power generation economically, a large part of the heat now thrown away might be turned to a useful purpose, particularly during the winter months. There appear to be many difficulties in this attainment, particularly if the heating is to be done with low-pressure steam. Using steam pressures around five hundred pounds or higher and expanding through turbines to about one hundred pounds into a heating system offer possibilities that have been little investigated, although such a plant of somewhat lower pressure has been put in service.

On many central power systems the winter load is considerably higher than that in summer. Loads of a character that would fill up the summer valley without adding to the winter peak would help to improve the yearly load factor of the system and raise the average yearly efficiency. There are many such loads available if they were only taken advantage of. These are in plants that generate their own power and have an excess of exhaust steam in the summer months and could, during this period, buy part or all of their power cheaper than generate it. This part of the power load the industrial plant could afford to pay a comparatively high rate for, and it could be produced by the central-station at a low cost, as all the equipment for generating and distributing the power is installed.

Where industrial plants are of sufficient size to warrant such an arrangement their reserve capacity could be used to assist in carrying the winter peaks on the central system and in this way further improve the central-station load factor, which in most cases is far from ideal. Of course, the central station could not be expected to carry this plan to the extent of increasing its own costs, but there are many plants that would be willing to buy part or all of their power in the summer months if some satisfactory arrangement could be made. Furthermore, they would be willing to purchase this power under conditions that would not increase the peak load on the central system. Although the chief benefit that the central station would obtain from such a scheme would come from improved load factor, it would work to encourage the combination of power and heating loads which results in producing power at a minimum number of heat units.

C. W. E. Clarke, in his latest A.S.M.E. paper on the Colfax station, gives valuable data on the cost of the station per kilowatt in its various stages of expansion. Further than this he takes a step worthy of special commendation in offering to exchange detailed cost figures with designers of other plants. Of all data cost figures are perhaps the most valuable to the profession. They are certainly the hardest to get. Over-conservatism in this matter tends to make power generation more costly for all to the extent that it retards engineering progress. The prevailing hesitancy with respect to the publication of cost figures is due largely to fear of misinterpretation. There may be a very good reason for one plant costing more than another. Fair comparisons may be assured by giving more detailed cost figures accompanied by comments on local building conditions, load factor, fuel cost, etc.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for October will be announced this month.

Says Hydrostatic Test Does No Good

We have an ancient rule of marine boiler inspection that calls for a hydrostatic pressure of one and one-half times the maximum allowable working pressure to be pumped up on the boiler once each year. If the boiler holds tight after the required pressure is attained, it will be declared acceptable.

It does not matter how the test pressure is built up; any old hand pump or power-driven pump will do if it will jerk up the pressure somehow to that required by this inspection. When this test has been performed, the inspector is supposed to look inside the boiler to see what damage has been done.

The eye of an experienced man and a small test hammer are all that is required to find out what condition a boiler is in. Leave the hydrostatic test out altogether.

Long Beach, Calif. ARTHUR JONES.

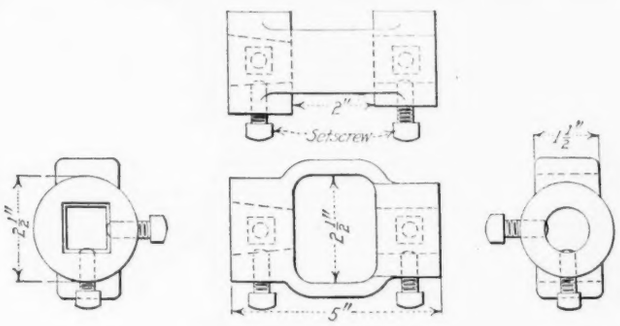
Coupling for Use with Extension Valve Stems

The connection between the operating stem of a valve and the extension stem from a valve-operating stand used in connection with it, can be made most conveniently and neatly by employing a valve-stem coupling such as is shown in the illustration.

With any arrangement for the operation of non-rising stem valves, from other than the floor level at which the valves are situated, extension stems are necessary. These stems can be connected with the valve stems by using sections of extra-heavy wrought pipe a little larger in diameter than the stems and about six inches long. These sections are drilled and tapped for setscrews near each end, so that at one end they can be made fast to the valve stems proper and receive the extension stems at the upper end. Sometimes sockets made to fit the operating nuts of the valves are welded to the bottom of the extension stems. Unless facilities are available to make such stems during erection on the job, it is difficult to get them of exactly the proper length.

A much neater and more satisfactory job can be obtained by using the cast-iron coupling illustrated. The lower end of the coupling has a square, cored, tapering hole of the proper size to fit the top of the valve stem in place of the standard operating nut with which the valves are regularly provided. The upper end of the coupling has a round cored hole to fit loosely a 1-in. rod from which the extension stems are made. Setscrews are provided for fastening the coupling to both the valve stem and the extension stem. The coupling provides for a variation of about 2 in. in the length of the extension stems. The extension stems used with this coupling can be shipped to the work a little long and cut with a hacksaw to the proper length.

This type of coupling was first developed and used extensively by one of the companies engaged in furnishing and installing equipment for rapid sand filter plants



Valve stem coupling

in connection with water-purification work. It is believed that the advantages and neatness of this type of coupling in power-plant work will be appreciated.

Norfolk, Va. C. L. B. ANDERSON.

Erratic Boiler-Water Level

In low-pressure steam-heating systems a vacuum is sometimes produced in the boiler with an apparent loss of water. It is frequently stated that the water leaves the boiler and backs up the return line. On opening the gage test cocks air is drawn into the boiler and no water level can be determined while the vacuum remains.

This condition with a correctly designed and operated installation is impossible, as the water in the boiler will not pass the return check and no steam is passed to the system during vacuum conditions.

It appears that the boiler operation is in all cases responsible for a vacuum in the system due to falling off of steam generation. Banking fires over long periods and leaving the firedoors open are the chief causes of vacuum by cooling off the boiler. This condition is often the cause of severe criticism of the installation, and little or no study is given to operation.

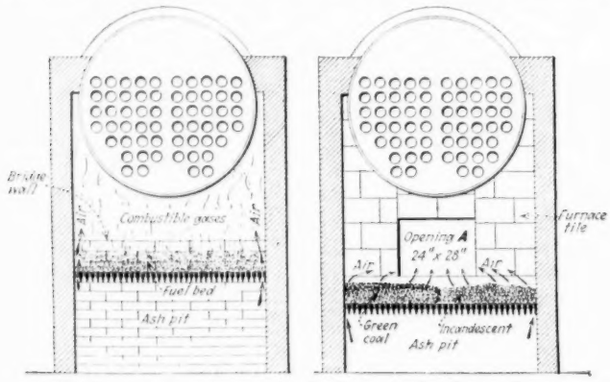
New York City. J. E. BOGGIANO.

Burning Low-Grade Coal

In the last few years I have had experience in burning nearly every grade of soft coal, both in stoker-fired and in hand-fired plants, as well as fuel oil in industrial power plants. It has occurred to me that suggestions relative to improvement in steam-generating methods may be of some value to other readers.

As the first step we will consider the question of whether or not the plants that have changed over from coal to oil, could not have made just as good a showing with coal if the men had been shown the proper way of burning the various grades. The average fireman, when he is given a poor grade of soft coal to burn, proceeds to fire in exactly the same way that he did with high-grade coal, blaming the purchasing agent, the coal dealer and the mine operator because he finds it difficult to keep up steam.

With the best grade of coal the average fireman believes in firing heavy charges at one time, carrying



Furnace arrangement before and after change

a fuel bed 12 to 15 in. deep, although this is not good practice where only natural draft is available. The thick fuel bed offers more resistance to the flow of air than a lighter one, and few firemen stop to consider that for every ton of coal burned, at least 15 tons of air must pass through the fuel bed.

I had charge of one boiler plant where a good grade of coal, costing $8.10 a ton delivered to the boiler room, was used and the purchasing agent and general manager were both in favor of using a cheaper coal costing $7 a ton. The cheaper grade was lower in fixed carbon than the other, and higher in volatile, but contained a higher percentage of hydrogen. I considered this an advantage since hydrogen contains 62,500 B.t.u. per lb. and if the volatile could be completely burned by careful firing methods, we could make a good showing with this coal. The firemen were accustomed to carrying heavy fires even though our draft was only 0.3 in. and after they had covered the fire with a heavy charge of green coal, dense smoke would pour from the stack for several minutes, indicating that the volatile gas was not being burned, fully 20 per cent of the heat value of our fuel being wasted in this way. After the volatile was all driven off, a hard crust would form on top of the fuel bed and the furnace would not get sufficient air, and this was usually followed by a drop in steam pressure.

The drop in pressure proved annoying to the management and resulted in quite a production loss. The general manager came into the power plant one day and said he thought that oil burning was the solution to the problem, and that it was cheaper to buy oil at market prices than to go back to the $8.10 coal. I said that I could secure fully as high an evaporation of water per pound of coal as was formerly obtained with the higher-priced coal if he would spend $200 on improvements to each furnace. This meant an outlay of $800 for the four boilers, and he was wary about adopting my scheme. I finally persuaded him to change two furnaces with the understanding that I would eliminate the annoyance of falling steam pressure and reduce his coal bill at the same time. The fuel consumption had jumped from 20 tons a day to 22 tons when we changed to the cheaper coal. The sketch at the right in the illustration shows the old boiler setting, with grates 30 in. below the shell and a very small furnace volume. The drawing at the left shows the grates lowered one foot, giving greater furnace volume.

In making the change furnace tile was built on top of the bridge wall all the way up to the shell, an opening *A* about 28x24 in. being left at the center. The gases from each side of the furnace have to pass through this opening, thus assuring better mixture of air and combustible gases.

In the ordinary setting considerable excess air leaks up at the edge of the grate along the side wall and, instead of mixing with the combustible gases, passes in a separate stratum along the side wall without mixing to any great extent. With the baffle built up on the bridge wall, the excess air leaking through the grates at the side of the furnace is forced to travel across the fuel bed and enter the opening *A*, mixing with the volatile and giving good combustion. After the change was made on two boilers, we decided to carry a light fire, not over 9 in. thick, and thus improve the air supply. The firemen grumbled at the idea of firing light and often, but we were determined to develop this idea as far as possible.

"If we cannot burn this coal economically, they will install oil burners and half of you men will then be out of a job", I told them when they claimed that it was too much trouble to be constantly firing only three or four scoops of coal to each furnace.

I would not allow them to cover the entire grate with coal at one time either. Four small shovelfuls were spread evenly over half the grate on one boiler, and this process was repeated on the rest, and then after a short interval the remaining half of the fire was covered lightly. In this way one-half of the fire was kept bright at all times, and the high temperature of the gas leaving this side was sufficient to burn completely the hydrogen and other volatiles that were distilled off when the other side was fired up, since they were perfectly mixed when passing through the opening at the center of the baffle.

As shown by the sketch at the left, the air will go in separate strata at the side and gases in the center, poor mixture results and volatile is not burned. By the arrangement shown at the right one side of the fire is at white heat and the temperature of the furnace is held high enough to burn the gases completely. Perfect mixture occurs since air must sweep across the fuel bed and any excess air from the bright side of the fire balances any deficiency of air that exists on the side that has been covered with coal.

After a few days the firemen found it surprisingly easy to keep up steam, and the fuel consumption was reduced three tons daily. Nineteen tons of coal at $7 a ton did the work of twenty tons at $8, and the fuel bill was reduced from $162 a day to $133. The money spent on improvements is insignificant compared with

the saving, while an oil-burning installation would require a minimum investment of $35,000 in storage tanks, pumps, heaters and burners. If all the boilers in the plant were remodeled after the same plan, considerably more money could be saved. In my opinion a furnace should be designed for the grade of coal it must burn, and if the coal is fired properly it will be just as economical as oil firing. If it is desired to reduce the labor cost, stokers or powdered-coal equipment are as good an investment as oil burners and will show lower costs in the long run.

Brightwood, Mass. ANDREW F. SHEEHAN.

Metallic Shaft Packing Caused Turbine Vibration

A turbine-driven boiler-feed pump was furnished with a water-sealed carbon packing when put into service. After short service the packing began to give considerable trouble, finally causing severe turbine vibrations and resulting in a badly scored shaft. Experiments were at once begun with various packings to replace this carbon type, and finally a metallic packing was found which, when used in the turbine-shaft glands, gave results better than those obtained with the packing furnished when the turbine was new. This packing, of square cross-section, was made up of a number of crimped metal ribbons pressed together loosely and covered with a sheath of closely braided copper wire.

After a year's satisfactory operation with this packing the old rings had to be replaced with new ones of the same make. Trouble from vibration and leakage soon developed. An examination of the turbine and packing was made to discover the causes of vibration. It was found that the manufacturer had changed the packing construction. The old-style packing which had given such good service was made up of an assembly of crimped metal ribbons pressed together and covered with a close braid of copper wire, and while the packing as furnished on the replacement order was the same in inside construction, the copper covering had been decreased until there was only a very loosely braided copper sheath, sufficient to hold the ribbons together until they were inserted in the stuffing box.

Since no other change could be found in the turbine, it was decided that the new-style packing sheath had something to do with the trouble. A larger piece of the old packing was hammered down to fit the stuffing box and the gland packed with it, whereupon the troubles ceased. A careful analysis of the packings has evolved the following explanation of the case:

The shaft was badly scored. When the packing was put in and squeezed up, the gland being then slightly released, the packing formed to the shaft contour. After a short period of operation it wore to form a close-clearance metal sleeve whose inner contour was that of the shaft and whose clearance formed an effective steam seal. This joint lasted until the soft metal inside the sheathing had disintegrated. The braided copper was sufficient to hold the metal in place, and the closeness of the weave prevented any loose ends of copper coming off the sheath.

With the new packing the copper wire was loosely meshed. Instead of having formed a close-clearance sleeve of comparatively resistant copper, a large portion of the sleeve was soft metal which gave way very quickly. The tightening necessary to keep the gland steamtight resulted in rapid wear on the copper sheath, the loose pieces dropping off and being carried around the shaft until they wedged, causing the vibration.

In this case although the cost of manufacture of the packing was lessened by the sheath change, its field of usefulness was much decreased. It was found to be satisfactory for new shafts but useless on worn ones. Consequently, a change to another design using a closely woven sheath became necessary.

Springdale, Pa. CHARLES E. COLBURN.

Soap and Water for Cleaning Cylinders of Air Compressors

While I will not undertake to advise the older engineers on the merits of soap and water for cleaning cylinders, for the benefit of the young engineer I will give my experience on the subject.

Several years ago I read a number of articles on the benefit to be had by the use of ordinary laundry soap mixed with water for cleaning air-compressor cylinders, ports and valves of carbon and gummy matter. After reading these articles, I became an enthusiastic user of soap and water and would be willing to fight with engineers on every occasion if they did not agree with me on the merits of this solution; still the valves continued to be coated with carbon, and if it was not scraped off, it would keep getting worse. At last I concluded that no soap could remove the coating that would form on the valves from burnt oil. Before giving up the idea, I put a carbon-coated valve in a pail of soapy water and left it in the solution for a week. When it was taken out, it was in the same condition as when put in. This convinced me that if a soaking of this kind did not clean it, feeding the solution through the cylinders in one puff never would.

At one of our mines we have two 2,000-cu.ft. air compressors equipped with feather valves and operating at 200 r.p.m. At another of our mines there are two 1,600-cu.ft. compressors of the same type. Some months ago I was at the plant where the 1,600-cu.ft. compressors are installed. The engineer in charge is a strong advocate of soap and water solution; he even uses a good toilet soap. He assured me that it kept the valves and pistons in good condition. At last I advised him to give the soap to the boys to wash up their overalls and the results would be the same. This remark displeased him, so it was up to me to make good.

I suggested that we look at the valves and pistons of one of the compressors, and on his next visit to my plant we would do the same. This he consented to do. After the plants had been looked over, he was willing to admit that the compressors that had no soap and water fed to them, were in the best condition.

There must be some reason for this, so I will try and explain it. Both plants use the same grade of oil, but his compressors got three drops of oil to ours one. This tends to keep the discharge unloader from working properly, which in turn keeps the compressor hotter than if the unloader was working as it should; this causes more carbon to collect on the valves and pistons. I recommend that the proper oil be obtained for the air-compressor temperature, and if no more oil be fed than is required to lubricate the parts properly, soap will not be needed. THOMAS PASCOE.

Norway, Mich.

Comments from Readers

Balancing of Turbines

In *Power* for Sept. 15, 1925, there was an article on rebalancing small turbo-generator sets. I used the method outlined years ago, and it is satisfactory, provided the stresses in the wheel are low enough to permit drilling the holes.

It is fairly safe to assume that the manufacturer did not put a chipping strip on the rim of the wheel unless the stresses were high. It would seem to be risky to drill and tap holes in the web as described, unless the manufacturer has stated that it is safe. I have seen several bucket wheels in which cracks started from holes in the web, either tapped or just drilled. If such holes must be used, the sharp edges at each end of the hole should be carefully rounded off until all tool marks are removed, the radius to be large enough to make the rounded surface extend at least $\frac{1}{8}$-in. beyond the depth of the thread.

However, it is safer still to drill and ream the holes large enough for a soft steel bush to be driven in with a press fit of about 0.0005 in. per inch of hole diameter and then rivet both ends over the rounded edges of the hole. The bushing must of course be drilled and tapped before it is inserted. This method is more expensive but much safer when the stresses in the wheel are high, for there are no scratches around the hole from which a serious crack can start.

Holes that are drilled in the web and used for equalizing the steam pressure on each side, or for pulling-off purposes, should have their edges rounded for the same reason. WERNER JOHNSON.

Cliftondale, Mass.

Amount of Coil Needed for Brine Tank

In the Nov. 3 issue of *Power* under "Answers to Questions," the answer to one asked by W. B. is open to question regarding its accuracy. In the first place, I would not assume this to be an ice tank because of the depth being eight feet, therefore would consider it as a brine-cooling tank.

The transmission of 200 B.t.u. per sq.ft. per hour per degree temperature difference is much too high. Where shell-type brine coolers are used, a transmission of 30 B.t.u. per sq.ft. per degree temperature difference is secured, but brine velocities must be and are very high. Where coils are designed to operate under the flooded system and conditions are otherwise correct, a transmission of from 18 to 20 B.t.u. may be attained. As frequently installed, pipe coils will seldom show a transmission to exceed 12 or 14 B.t.u.

The old practice of installing about 150 lin.ft. of $1\frac{1}{4}$-in. pipe to a ton of refrigeration is still followed to a great extent. This allows about 12.3 B.t.u. per sq.ft. per degree temperature difference, assuming a temperature difference of 15 degrees.

Under the conditions of 6 lb. suction pressure stated in the inquiry, a compressor of 150-ton refrigerating capacity will produce about 68 per cent of its standard rating. Therefore each machine will have about 102 tons capacity, or a total of 204 tons. On a basis of 150 ft. of $1\frac{1}{4}$-in. pipe to a ton this will require 30,600 lin.ft.

If the coils are designed for the flooded system and the brine circulation is efficient, a transmission of 18 B.t.u. may be attained.

The coil temperature is —15 deg. F. and the brine is at +5 deg. The transmission per square foot per hour $= 18 \times 20 = 360$ B.t.u. The square feet required per ton are $12{,}000 \div 360 = 33.3$. As 2.3 lin.ft. of $1\frac{1}{4}$-in. pipe equals one square foot of external surface, $2.3 \times 33.3 = 76.6$ lin.ft. of pipe is needed per ton of refrigeration. However, as it is impossible to insure every foot of pipe to be active, an allowance of from 25 to 30 per cent of excess coil should be provided. In this case, allowing 30 per cent, there would be required approximately 100 lin.ft. to the ton, or a total of 20,400 lin.ft. of $1\frac{1}{4}$-in. pipe.

If a suction pressure of 9 lb. gage is carried, which will give an evaporating temperature of 10 deg. F., the total difference will be 15 deg., and under this condition the machines will have a refrigerating capacity of 78.6 per cent of standard rating, or a total of 236 tons refrigeration in 24 hours. This will require 23,600 lin.ft. of $1\frac{1}{4}$-in. pipe in the tank, and the power cost per ton of refrigeration delivered will be reduced.

Chicago. M. R. CARPENTER.

Measuring Coal on Traveling-Grate Stokers

With reference to the letter by E. Ogur in the Sept. 22 issue, in which he comments on my comments in the July 14 issue on "Measuring Coal on Traveling-Grate Stokers," it would appear that he has misinterpreted some parts of my letter.

I attempted to bring out the point that many engineers treat records as being exact, when in most engineering problems it is impossible to obtain the exact results. I cited the case of the paper by Alfred Cotton before the A.S.M.E., in which he brought out the various errors that crop into a boiler test conducted according to the specifications of the A.S.M.E. Test Code. I meant to bring out the fact that it is useless to halve or quarter a B.t.u. or a pound of coal or a pound of water when the records could not be obtained with that degree of accuracy. Every time some experimenter conducts careful research on the properties of steam, we find it necessary to change our tables. I did not mean to infer that in any project it is not well to aim as high as possible, so that if we do fall short, we will in the end be higher than if we did not aim so high.

Mr. Ogur got onto the subject of "beliefs" in his last paragraph and cited some disastrous results which could occur from the belief that a valve is shut, gun not loaded, etc. The simplest answer to this is that

in each one of these cases these things can be positively checked, whereas in the matter that we were considering, many things could not be checked exactly.

It was not my intention to place the flow meter in the "revolution counter" class, and I think a careful reading of my letter would show that Mr. Ogur misinterpreted it. What I did say was that in many cases if the flow meter happened, for some reason, to have considerable error, it could be placed where it would still be exceedingly useful. I cited the case of a flow meter on a boiler that I was familiar with, which showed the boiler to be doing practically nothing, and stated that an apparatus of doubtful accuracy would have easily shown this condition. There is no doubt that the flow meter, when properly installed, is an accurate instrument, and its records are very useful in power plant operation.

I have been asked by Mr. Ogur to mention for the readers of *Power* some useful purpose that approximate records will serve. In answer to this, I wish to say that a complete boiler evaporative test conducted in accordance with the A.S.M.E. Code will be very useful. These records, while approximate (see Mr. Cotton's paper before the A.S.M.E., 1923), no one can deny will serve a very useful purpose.

Philadelphia, Pa. J. W. Hogg.

Setting the D Slide and Piston Valve

Referring to my letter in the Sept. 1 issue on "Setting the D Slide and Piston Valve," I notice a typographical error in the next to the last paragraph, which reads in part as follows: "After assembling the governor wheel eccentric and yoke on the engine shaft, we calculated the length of the new eccentric rod and got it welded at the forge shop." I intended to say that we determined the new length of the eccentric rod, not by calculation, but by direct measurement.

The method described herewith, also the accompanying sketch, which supplements the illustrated article in the Sept. 1 issue, was developed while building and erecting engines designed by the late E. F. Williams. In a number of cases the governor wheel was set for marking off the keyway without the cylinder being on the engine frame at all, only the crankshaft in the bearings, and the eccentric rod leading off in its correct line of motion. It shows that the correct position of the governor wheel is determined by the movement of the governor eccentric center from the maximum valve-travel position to minimum travel inside of the lap circle, and the direction of the center line of motion of the eccentric rod leading off from the shaft, though, in this case and for analysis, it coincides with the center line of cylinder, piston and connecting rod. The path of the eccentric center in this movement is determined by the type of governor, whether centrifugal, as in this case, or the inertia type, as described on page 221 of the Aug. 11 issue.

We have distributed among our engineers and oilers, a number of copies of "Power Catechism," and Low's "Steam Engine Indicator" is in constant use in the engine room. Also, Low's "Compound Engine" is steady diet in the solution of our problems of the use of steam in the compound engines, so it is in an endeavor to answer some of the "How and Why" that the accompanying sketch and description are submitted.

Referring now to the illustration in the Sept. 1 issue, showing a piston valve in the center of its travel, we regard this as fundamental and the real starting point of correct valve setting.

The necessary measurements were taken by laying a "stick" (or "lath," as the old-timers called it) and marking off the edges of the ports in the valve bushings, after they were drawn into place, then transferring this stick to the valve, to see that the exhaust edges of the ports and valve line properly, and the steam edges of the valve have the required lap. Then assemble in place and connect the link to the rocker, and see that the rocker is in mid position.

Referring now to the illustration herewith, the crank-end center *A* was chosen because it leaves the exhaust edge of the valve open at the head end, the lap plus the lead in this case being $2\frac{7}{8}$ in.

When the valve is moved into the position of $\frac{3}{8}$ in. steam lead at the crank end, which is covered up but easily measured as shown at the head-end exhaust, the governor was assembled on the shaft with the pivot of the swinging eccentric *F* at such a position in advance

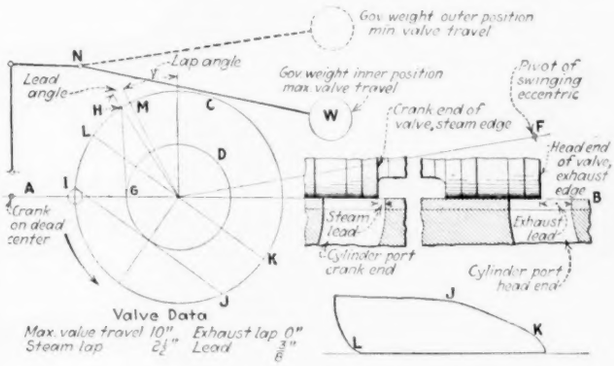


Diagram used to illustrate movement of eccentric center and valve

of the center line of motion as to give the $\frac{3}{8}$-in. lead angle at *H*. The lap angle was built in the layout of eccentric center.

So with the eccentric rod supported in its line of motion, but not connected to the rocker, the governor weight was moved from the inner to the outer position. This in turn moves the eccentric center from position *H*, the lead angle, to the point *G*, inside the lap circle *D*, or the equivalent of the valve and stem $\frac{7}{16}$ in., which is $\frac{3}{8}$ in. lead plus $\frac{1}{16}$ in. negative lead. With the governor wheel in this position the weight was moved to the inner stop returning the eccentric center to the point *H*.

Then the valve was moved forward to the exhaust lead, $2\frac{7}{8}$ in., as shown, and the new length of the eccentric rod determined by direct measurement and welded up and connected to the rocker. Then after final check-up, the governor springs were coupled up and adjusted for initial tension, the steam-chest cover put on, the crank pried off center, and the engine started under steam ready for the load, and the application of indicator and any further adjustment of governor springs.

The lower half of the circle and the hypothetical indicator diagram is the well-known Sweet's Valve Diagram, first known to me from Professor Sweet's articles in the *American Machinist* of August, September and October, 1884, which I have before me now.

Youngstown, Ohio. D. P. Tolton.

Questions and Answers

Conducted by

Franklin Van Winkle

Static Head and Dynamic Head of Pump

What is the meaning of static head and of dynamic head against which a pump works, and how is each found? C. H. G.

The actual vertical lift measured from the standing level, or equivalent standing level of the suction water, to the useful standing level, or equivalent level to which the water is raised, generally is known as the static head against which the pump works and is found by actual measurement of the difference of the elevations, or by determination of the difference shown by pressure gages when the water is at rest, or by combining those methods, according to the requirements of the conditions.

The dynamic head is the total head against which the pump works and consists of the static head plus all losses of head except those within the pump itself. Hence the dynamic head, or head actually delivered by the pump, is equal to the difference between the head with which the water enters and that with which it leaves the pump and can be measured when the pump is running by taking the difference in readings of absolute pressures indicated by pressure gages placed at the same level in the suction and discharge lines close to the pump; or where the pressure gage on the suction side must be at lower level than the one on the discharge side, the head represented by this difference of gage levels must be added to the difference of head interpreted from the gage readings.

Use of Pressure and Surge Tanks on Hydraulic Elevators

Why are pressure and surge tanks used on hydraulic elevators? Why could the pump pressure not be applied directly to the elevator engine? When leaks occur in the pressure systems, how should they be repaired? M. A. M.

The purpose of the pressure tank is the storage of a quantity of water under air pressure, where the surge tank is to receive the water discharged by the elevator engine when the car is in the down motion and also to act as a storage to supply the pump. It is necessary for economy and smoothness of operation, to have an elastic head for the pump to work against and a considerable supply of instantly available energy for the elevators. Water can be supplied directly to the cylinders without the medium of a pressure tank, but the operation would be unsatisfactory and uneconomical. The pressure tank is cylindrical in form, preferably set horizontal; its capacity depends both upon the number and capacity of the elevators operating from it, and upon the available space for its location. Preferably, it should be of triple-riveted, double-strap, butt, longitudinal-seam construction, and if over 72 in. in diameter, the girth seam should be double-riveted. Double-riveted girth seams may not be necessary to withstand the internal pressure, but they are desirable because of their rigidity. The heads should be convex in order that internal bracing may be limited to a single through-stay.

The slightest leak anywhere in the piping or in tank seams should have immediate attention. The calking of leaks in pipe connections is not approved. The proper way to repair the condition is to take off the screwed flange or other connection, determine the extent of corrosion that may have taken place due to the leak, and either discard the corroded piece of pipe or have a new thread cut, whichever appears to be the better expedient. Slight leaks in tank seams may be calked, provided they have been in evidence for only a short time. But it is best to cut out a few rivets near the leak and if the rivets or rivet holes are found to be corroded, then the holes must be reamed and a larger-sized rivet driven. Then the seam should be calked. Repairs to tanks should be undertaken only by competent men, and under no circumstances should calking be attempted when the tank is under pressure.

Benefit of Installing Turbine for Relief of Overloaded Engine

The boiler-feed water of our plant is heated from 40 deg. F. to 80 deg. F. by exhaust of auxiliaries, as the engine is overloaded. What would be the gain in economy from putting in a non-condensing turbine to relieve the engine of overload and furnish enough exhaust steam at 1 to 2 lb. gage pressure for raising the feed-water temperature from 40 to 210 deg. F.? P. E. M.

The advantage gained from increasing the temperature of a given quantity of feed water would amount to about 1 per cent of fuel for each 10 deg. higher feed-water temperature, and for 210 deg. F. in place of 80 deg. F., such gain of fuel economy would be about $(210 - 80) \div 10 = 13$ per cent. The advantage or disadvantage of installing the turbine would depend on the economy of the engine as at present loaded, and when relieved of the power developed by the turbine taken with the steam economy of the selected turbine when so loaded.

The economy of a turbine of given type and size depends on the initial and final steam pressure, quality of steam supplied, and the percentage of full load carried. Since the economy of the engine also would vary with the percentage of its full load, a determination of the most favorable proportions to be carried by the engine and turbine would decide the advantage of their combined economy over the present overloaded engine economy. It then would become evident what net benefit could be expected from installation of the turbine unit with increase of the feed-water temperature.

A new slant on things observed in and out of the power plant

What Happens and Why?

How to Make a "Z" Diagram

IN ITS simpler forms the type of computing chart known as a "Z" diagram is easy to construct. To get the idea, draw two parallel lines *A* and *C* (Fig. 1) any convenient distance

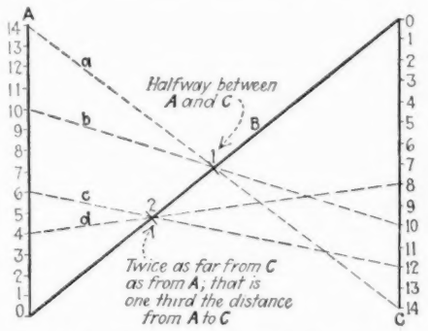


Fig. 1—Simplest form of "Z" diagram for A × B = C

apart. Connect one pair of opposite ends by a slanting line *B*, completing the "Z". Now lay off a scale of any sized units on *A*, starting with zero at the intersection with *B*. Lay off a similar scale on *C*, also starting with zero at the intersection with *B*, but running in the opposite direction (in this case downward).

Now imagine a straight-edge (represented by dotted lines such as *a*, *b*, *c* or *d*) pivoted about any point on *B* and note the intersections of this edge on the scales *A* and *C*. When the straight-edge is swung around until it lies on the line *B*, it will obviously intersect both scales at zero. Swinging from this position in the direction of motion of the hands of a clock, the movement down along *C* will be exactly proportional to the movement upward along *A*. If the pivot is located at 1 (a point equally distant from *A* and *B*) the movement on one scale will equal that on the other. For instance *a*, drawn from 14 on scale *A*, will pass through 14 on scale *B*. In the same way *b* will pass through 10 on both scales.

It is evident that 1 can be located as the intersection on *B* of a line connecting any two equal values on *A* and *C*. Once located, a straight-edge swing around it as a pivot will always give the same reading on both scales. Pivot 1 may therefore be used to multiply any value on *A* by unity.

Suppose we want to multiply the values on *A* by 2. Connect any value on *A* with its double on *C*, for example 6 with 12 by the line *c*, or 4 with 8 by the line *d*. Put the number 2 where *c* or *d* crosses *B*. Measurement will show that point 2 is twice as far from *C* as from *A*, which explains the doubling effect. The number 2 on this point signifies that when used as a pivot it will multiply any value on *A* by 2, the product appearing on *C*.

The scales *A* and *C* need not have equal divisions as long as each is a regular scale. For example, the divisions on *A* in Fig. 2 are larger than those on *C*, yet the multiplying points on *B* are located in the same manner.

A line from 6 to 6 gives point 1 on *B*, one from 2 to 6 gives point 3, while one from 2 to 7 gives point 3.5, etc. After scale *B* has been constructed in this manner and the construction lines *a*, *b*, *c*, *d*, etc., erased, any value on *A* may be multiplied by any value on *B* by passing a straight-edge through the two points and noting the intersection on *C*, which is the product.

The principle here shown can be used to construct a diagram to solve any formula involving simple multiplication or division (division can be converted

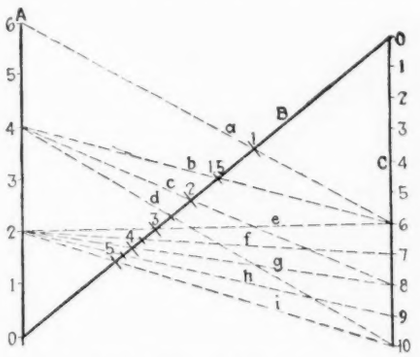


Fig. 2—"Z" diagram for A × B = C, with unequal scales

into multiplication). Fig. 3 shows a "Z" diagram built to solve the formula,

Boiler efficiency = equivalent evaporation × 970 ÷ heat value of fuel.

First turn it into a formula of multiplication as follows:

Efficiency × heat value ÷ 970 = equivalent evaporation.

Draw lines for *A* and *C*, as indicated, and construct on them large scales for heat value and equivalent evaporation, filling the sheet with the portions of these scales likely to be encountered in practice. The divisions may be of any convenient size. Note that *A* reads up and *C* down. Extend both scales (on a larger sheet pinned below the smaller one) to zero, and draw *B*, completing the "Z".

The graduations on *B* are easiest located by trial. Note that when heat value equals 9,700, the formula becomes:

Efficiency × 10 = equiv. evaporation, or per cent efficiency = equiv. evaporation × 10.

So if lines are drawn from 9,700 on *A* to equivalent evaporation on *C*, they will cut *B* at per cent efficiencies ten times as great. Thus line *c* to 6 on *C* will pass through 60 per cent on *B* and so on. After completing the scale *B* in the manner indicated, the parts

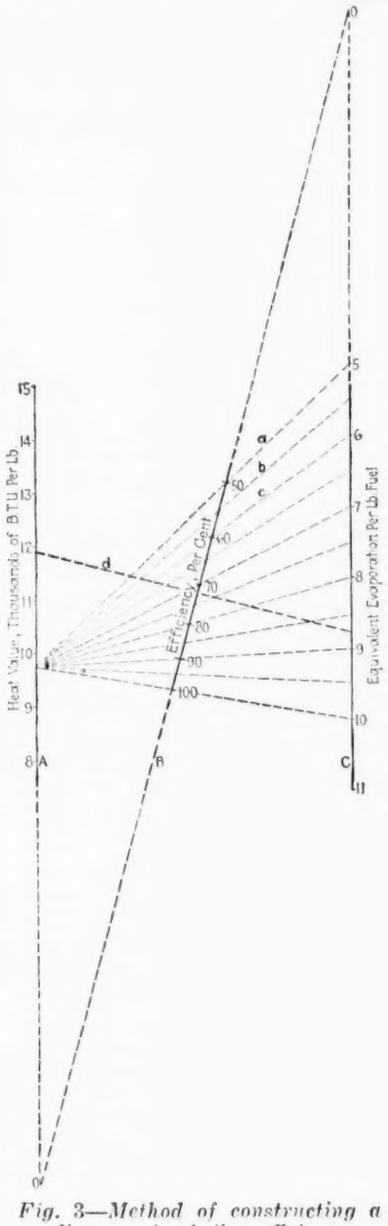


Fig. 3—Method of constructing a diagram for boiler efficiency

in solid line can be inked in and the dotted construction lines erased.

Now we have a chart for boiler efficiency. For example, a straight-edge laid as at *d* shows that if the heat value is 11,900 and the equivalent evaporation 8.8, the corresponding efficiency (on *B*) is 72 per cent. By making the diagram sufficiently large, any desired degree of accuracy may be obtained.

Muscle Shoals Reports Made Public by President Coolidge

Majority Report Recommends Leasing as a Unit—Minority Report for Separation of Power from Fertilizer Production

PRESIDENT Coolidge made public Dec. 1 the disagreeing reports of the members of the Muscle Shoals Commission which he will submit to Congress next week for guidance in legislation affecting the disposition of this government's water-power projects on the Tennessee River.

The report of the majority signed by Chairman McKenzie, former Senator Dial, of South Carolina, and R. F. Bower, recommended the leasing of the Muscle Shoals property as a unit to private interests if satisfactory lessees can be obtained, and in the event of failure to obtain satisfactory leases within ninety days, that the government operate the plants.

The report of the minority, signed by Prof. Harry A. Curtis, of Yale, and William McClellan, of New York, recommended the leasing of the Wilson dam, the hydro-electric power generated there and the steam-electric power generating plant at Nitrate Plant No. 2 for a period not to exceed fifty years under certain conditions. It would have the power and fertilizer production leases separate and urged the appointment by the President of a commission of five members to arrange for leasing the properties separately.

"There should be definite limitations placed upon the power to be distributed from Muscle Shoals," says the majority report, "in order to protect the power supply for fertilized manufacture, which is the primary purpose of the enterprise. We do not believe, however, that the hydro-electric properties at Muscle Shoals should be operated as isolated plants. This plan would not be economic because the water supply, and therefore the power supply of the Tennessee River, is variable, and a larger supply of power for all purposes would be made available by interconnecting these plants with the general distribution system of the Southeastern States.

"Power transmission, to be most effective, should take place in both directions, and the resulting exchange in power would have great economic value to the entire section. It is pertinent, in this connection, to state that only eight of the eighteen units provided for have been purchased, and more could be installed and used from time to time as the demand justifies.

"Since, in our judgment, the operation of the nitrate plants can best be accomplished and their benefits for the national defense and to agriculture can best be assured, by considering and dealing with the properties so dedicated above as a unit, they should be leased as a unit and not as separate entities."

In discussing the alternative of government operation, the majority report says:

"It is with great reluctance that we turn toward government operation, being well advised of all of the infirmities inherent in such an undertaking. The great investment of the government at Muscle Shoals, however, the importance of its continued maintenance as a part of our national defense, the crying need of agriculture for more and cheaper fertilizer and the favorable opportunity for meeting that need, all compel us to disregard our prejudices, for we are convinced that to longer permit this great investment to stand idle when it can be of such great service to our people would be little less than a public calamity.

"Delay in this case is expensive. Legislative action is imperative."

The minority report urged separate leases of the various power and fertilizer plants under numerous requirements, one being that they pay as an annual rental for the properties a sum equal to 4 per cent of their fair present value, estimated to be $42,000,000.

Another Novel Power Scheme from Germany

Startling power schemes are constantly originating in Germany. The latest was published on Nov. 27 in Berlin and reported in the press as follows: To build near Leipzig a steel tower 1,950 ft. high—that is, twice as tall as the Eiffel Tower—which is to serve a double function as a generator of electric power, with giant windwheels, and as a wireless station. A similar tower also is under discussion for Berlin, but the one near Leipzig, it is stated, has already been financed.

The chief purpose of the tower is to generate electricity, and according to the announcement, it will have a power capacity of 6,000 kw., costing one fortieth of a cent a kilowatt. This will be generated by two enormous windwheels of three blades each, which will stir in the gentlest breeze and will be attached to a large framework nearly 800 ft. above the ground.

The cost of the tower is put at $1,000,000. The electrical machinery will cost a further $500,000.

A. S. M. E. Awards and Prizes Bestowed at Meeting

The A.S.M.E. awards and prizes were presented on Dec. 2 at the forty-sixth annual meeting by Dr. Ira N. Hollis, chairman of the Committee on Awards and Prizes, to the following recipients:

The Charles T. Main Awards to Clement R. Brown, Catholic University, Washington, D. C.; Junior Award to Gilbert S. Schaller, assistant professor of engineering shops, University of Washington, Seattle; Student Awards to (1) joint award to E. Ray Enders, Jr., and William S. Montgomery, Jr., Pennsylvania State College, State College, Pa.; (2) Harry Pease Cox, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Florida Power Plant To Be Ready in 1926

The largest artificial body of water is to be formed at Cherokee Bluffs, Fla., by a hydro-electric dam under construction at that point by the Alabama Power Co. The dam will be completed in the summer of 1926 and 180,000 hp. will be developed.

The Cherokee Bluffs dam will impound 530,000,000,000 gal. of water. The dam at Muscle Shoals contains 170,000,000,000 gal. The Ashokan and Kensico Reservoirs contain respectively 150,000,000,000 and 40,000,000,000 gal. The Roosevelt Dam, which hitherto has been rated as the world's largest artificial body of water, impounds 420,000,000,000 gallons.

The Alabama Power Co. is spending about $1,000,000 in cleaning the dam before it is flooded.

Blames Inspection Service for "Mackinac" Disaster

Harry E. Morton, of Canton, Mass., former State Boiler Inspector of Massachusetts, in a lengthy interview laid before Judge Davis, solicitor of the Department of Commerce, the results of his own investigation of the "Mackinac" explosion which occurred at Newport, R. I., Aug. 18, killing fifty-one persons and injurying about one hundred more.

In Morton's opinion, based on his own examination of the "Mackinac's" boilers, the responsibility for the explosion is largely on the government, because of what Mr. Morton asserts was faulty inspection by the steamboat examiners who examined the boilers at New York last April, and this faulty inspection, Mr. Morton asserts, was due largely to the inadequacy of inspection methods as provided by the law and regulation.

Secretary Hoover, in his annual report, recommends revision of the Steamboat Inspection laws.

Refrigerating Engineers Discuss Their Problems

The annual meeting of the American Society of Refrigerating Engineers was unusually successful in that the papers covered a wide range of subjects.

The Monday, Nov. 30, morning session was devoted to routine business and to reports of the several committees, after which the tellers' report on the election of officers was made.

Those who will guide the society's affairs during the coming year are: President, L. H. Jenks, New York; vice-president, George B. Bright, Detroit; treasurer, William Whitten, New York; secretary, W. H. Ross, New York; directors—H. B. Edwards, New York; F. M. Aday, New York; B. H. Coffey, New York; L. A. Ramsay, Brooklyn; A. W. Oakley, New York.

Following this came the address of the retiring president, Van R. H. Green, who outlined the new developments and tendencies in the science of refrigeration.

At the Monday afternoon session L. H. Jenks discussed the results of tests run on a high-speed Frick compressor. Data were cited showing that the horsepower per ton of refrigeration showed but a slight increase in raising the speed from 180 to 230. The volumetric efficiency remained unchanged. R. H. Switzler gave an exhaustive report on the explosion that occurred in the Laclede Building in St. Louis some weeks ago. It was his conclusion that the ammonia system was not a factor, the explosion being due to the ignition of city gas leaking from a poorly built house line.

C. S. Crogoe presented a paper on the specific heats of ammonia.

A paper by R. S. Jessup, Bureau of Standards, on the "Properties of Refrigerating Brines" was of interest and should prove of value to the engineer, although the tables and charts would be more workable if in English units.

In a paper on "Welded Pressure Vessels," by L. H. Roller, it was the conclusion that a hammer test cannot be relied upon to show up a defective weld, but the hammer test does not weaken the weld. Hydrostatic test at 1½ working pressure did not always show up welding defects.

Synthetic ammonia was the subject of papers by Frederick Pope and J. R. Powell. These covered the history of ammonia and the processes used in obtaining the synthetic product.

On Tuesday afternoon a joint meeting was held with the American Society of Mechanical Engineers; abstract of the papers will be found in the report of the A. S. M. E. meeting.

Tuesday evening the annual dinner and dance was held at the Hotel Astor. As is usual with the Refrigerating Engineers, the affair was well attended.

On Wednesday, W. H. Motz gave a number of nomographic charts of use to the refrigerating engineer. The oil engine as a prime mover for compressor drives was discussed by F. W. Green, while Prof. Hugh E. Keeler covered the absorption type of household refrigerating plants.

The annual meeting ended with trips to several ice plants.

Chief of Engineers Reports on Power Resources in Industrial Areas

Initial Survey Has Been Made of Continental United States

IN HIS ANNUAL report to Congress the Chief of Engineers reports on the survey that the Army is making of the power resources in industrial areas. On that subject General Taylor says:

"A survey of the electric power plants and resources of the United States was commenced during the fiscal year 1922, under authority of the national defense act of June 4, 1920. It was desired by this means to obtain information and to develop plans which would enable the Nation to utilize to the utmost all available electric power in time of war, and to assure the fairest and most efficient distribution to industries which would be engaged in work essential to the prosecution of hostilities. During the World War the government established a measure of control over electric power, as described in War Department Document No. 1039, 'The Power Situation During the War.' The present survey is based upon and is planned in furtherance of the lessons therein set forth.

"During the past year matters in this office pertaining to this survey have been handled in the office of the resident member of the Board of Engineers for Rivers and Harbors.

"The objects of the survey are to collect data on existing power companies of over 5,000 kw. capacity; to establish contact with the principal men in the power-production business; to seek the co-operation of producers in so planning their extensions and new developments as best to meet war-time needs; to ascertain the possibilities of increased power development in combination with navigation improvement, flood control, or otherwise; and to ascertain the best system for the government to adopt for developing power resources and for administering power distribution in a national emergency. Especial emphasis is being laid on close co-operation with the large power producers and interests, as it is realized that only in this manner can a successful system be devised. Duplication of work done by other government bureaus is being avoided, and every effort is made to utilize existing data to the fullest extent practicable. The study is not taking the form of costly field investigations, but is being conducted by personal conferences and correspondence with power producers at slight cost beyond occasional trips to large power centers.

"An initial survey of the situation for the entire continental United States has been completed, and a report based thereon was during the year transmitted to, and approved by, the Assistant Secretary of War. The plan contained in this report contemplates the division of the country, for peace-time investigation and war-time administration, into 11 territorial power zones. During peace-time the necessary work and investigation in each power zone will be under a division or district engineer located therein. Annual reports will be submitted by these, and based thereon, the Chief of Engineers will transmit annually to the Assistant Secretary a project, revised up to date, for co-ordination and administration of power resources in an emergency."

President Coolidge To Open Tacoma Power Plant

President Coolidge has honored Tacoma by expressing his willingness to start the operation of Tacoma's new $5,000,000 hydro-electric power plant early in January, 1926, by pressing a button at the White House. Wesley L. Jones (R.), Senator from Washington, put the matter before President Coolidge.

Ford and Edison Seeking Old Patent Models

Thomas A. Edison and Henry Ford are among the 2,000 applicants for some of the 150,000 old patent office models now being sorted by a commission authorized by Congress. Mr. Edison's request for originals of his earlier inventions covers five closely typewritten pages.

Mr. Ford wants to preserve models of mechanical engineering devices for study, and Prof. Carl N. Mitman of the commission and curator of engineering at the Smithsonian Institution, is collecting these for Ford.

Princeton University To Have Engineering Laboratory

Complete plans for a new engineering laboratory for Princeton University to be unsurpassed in equipment by any in the country, were made public on Nov. 28. According to Dean Arthur M. Greene, the structure, which is to cost approximately $500,000, will be ready for use in about two years. Despite the complete outfitting of the laboratory, it will be built to accommodate only 400 men, the maximum enrollment of the Princeton Engineering School being limited to that number.

The external plans of the laboratory provide for its construction along the collegiate Gothic lines in accord with which Foulke, Henry, Holder and Pyne Halls and the University Commons have been built. It will also be handled by the same firm of Philadelphia architects.

Among the chief engineering advantages which the laboratory will have will be a hydraulic department and two rooms devoted to the study of internal-combustion and steam engines. The south end of the building will include in its equipment pumps, turbines, apparatus for testing and research and a flume in which the resistance to the flow of water of ship models, engineering structures and similar objects can be ascertained.

New Engineers License Bill for District of Columbia

A bill providing for the licensing of engineers in the District of Columbia, drafted by the Commissioners, has been approved in principle by the Citizens Advisory Committee. The bill is to be introduced in Congress in the near future.

The measure proposes the creation of a board of five engineers to pass upon the qualifications of those who apply for license.

One member of the committee objected to any such proposition, characterizing it as "vicious class legislation." He declared that during long residence in Washington he has known of no fraud involving an engineer. "The public does not have to be protected against them. I object to placing them on the same plane with plumbers," he declared.

Despite the vigorous objections of this member the principle of the legislation was approved, but exception was taken to the provision giving the board control of the funds which would accrue from license fees. The idea is that they should be covered into the Treasury and the board's expenses be provided for in the usual way by appropriations. There also was insistence that the law fix a maximum fee rather than leave that to discretion of the board.

The bill extends eligibility to Canadians, which aroused objection on the ground that it was unfair to the nationals of other countries.

N. Y. Commission Protest Great Lakes Diversion

Protesting to President Coolidge against the proposed diversion of the waters of the Great Lakes for the development of Mississippi Valley navigation projects, Attorney-General Albert Ottinger, counsel for the New York State Water Power Commission, points out in a letter that any draft of great quantities of water from Lakes Erie and Ontario "would cause incalculable damage to the commerce and industries of the State of New York."

Attorney-General Ottinger wrote President Coolidge: "I have likewise learned that the Mississippi Valley Association and other organizations representing various localities are urging you to give your attention, both in your annual message and through the government's administrative officers, to the prompt development of the so-called Mississippi Valley Navigation projects.

"It has been stated that the carrying out of the Mississippi scheme will require the diversion of waters from the Great Lakes by artificial channels to the Mississippi area and would thus prevent them from flowing in their natural course through Lakes Erie and Ontario and the St. Lawrence River to the sea.

"As Attorney-General, I am a member of the New York Water Power Commission and its counsel. I view with great sympathy any measure that will benefit the Mississippi Valley and its citizens. I feel that any project that will aid the great agricultural section of the nation deserves the support of all the states.

Anthracite Operators Refuse Pinchot Plan

Ten of the points proposed by Governor Pinchot for a settlement of the anthracite strike and accepted unreservedly on Nov. 29 by John L. Lewis and representatives of the United Mine Workers, are: That the price of coal shall not increase because of the suspension or the new agreement; that the agreement shall extend at least five years; the creation of a Board of Investigation and Award comprised of two men chosen by the miners, two by the operators and three by these four; the Board to investigate whether the operators can pay increased wages without increasing the price of coal; the Board to organize within thirty days and make its report within six months; records of miners and operators to be open to the Board, but not to the public; after making its award, the board shall study methods of avoiding strikes and increasing mine efficiency and operation; full recognition of the union not granted, but operators shall honor voluntary written request of a miner to assign his present union dues, not exceeding $14 a year; working conditions not specifically mentioned, to be referred back to representatives of miners and operators for settlement; Board of Conciliation established under Roosevelt settlement of 1903, which never functioned, to proceed at once to equalize wages, wages not to be reduced during the five-year agreement unless as the result of such equalization; suspension end at once and anthracite mining operations to begin immediately.

The anthracite operators' committee met at Philadelphia on Nov. 30 and unqualifiedly rejected Governor Pinchot's plan. The operators' reasons for refusing to consider Governor Pinchot's proposals were embodied in a letter signed by Major W. W. Inglis. Chief of the objections advanced by the operators were: The Board of Investigation and Award, which, the operators say "has the power to do but one thing —increase wages"—is not arbitration "and cannot be accepted as a substitute for real arbitration."

The Governor's proposal would have the hard-coal operators "repeat the Jacksonville mistake of endeavoring to maintain high prices to pay high wages through the simple formula of writing them into a contract" for five years. An agreement on prices would be illegal and no producer could bind himself to maintain prices, which "are controlled by the law of supply and demand and cannot be maintained at artificial levels by arbitrary agreement."

An increase in wages if profits permitted would be "unsound," and "it would have been more logical to suggest that if profits are excessive and labor well paid, prices should be reduced."

The "voluntary" check-off proposed by Governor Pinchot and accepted by the miners is "repugnant to reason and justice and a barrier rather than an aid to sound industrial relations." The check-off would result in "coercion and intimidation," would not eliminate strikes and would result in the union having, according to a recent Federal court opinion, "an absolute monopoly of all labor engaged in such industry."

Columbia Power Station To Open Dec. 10

The opening of the Columbia Power plant, formerly called the Miami Fort plant, of the Columbia Power Co., Cincinnati, Ohio, will have Owen D. Young of the General Electric Co. as the principal speaker at the banquet to be held in connection with the dedication ceremonies at the Sinton Hotel, Cincinnati, on Dec. 10.

Others who will speak are Philip O. Geier, president of the Cincinnati Chamber of Commerce; Philip G. Gossler, president of Columbia Gas & Electric Co., and W. W. Freeman, president of the Union Gas & Electric Co. of Cincinnati.

Virginia Junggren, daughter of the General Electric Co. engineer who designed the turbines for the station, will open the throttle that turns on the steam, after which Charles P. Taft, of Cincinnati, will close the switch that releases the station's electrical energy into the transmission lines of the Union Gas & Electric Co., serving the Cincinnati district. The initial capacity of the new station is 90,000-kw., or 120,000-hp.

Boston Fuel & Power Meeting Program Announced

An announcement of the detailed program of the Fuel and Power Meeting of the Affiliated Technical Societies of Boston, scheduled for Dec. 10-11, at Huntington Hall, Boylston St., a preliminary report of which was published on page 873, Dec. 1 *Power*, is as follows:

Thursday morning, Dec. 10—"Sources and Utilization of Fuels," Dr. Ira N. Hollis, presiding; "Sources and Utilization of Coal," by F. H. Daniels, vice-president and general manager, Riley Stoker Corp.; "Sources and Utilization of Oil," by E. H. Peabody, president Peabody Engineering Corp.; "Diesel Engines," by J. F. Hecking, Worthington Pump & Machinery Corp.; "Possibilities of Obtaining Power from Public Service Corporations," by L. R. Nash, vice-president, operating division, Stone & Webster, Inc.

Thursday afternoon, Dec. 10—"Requirements of Power in the Industries," President S. W. Stratton, M. I. T., presiding; "Power for Textile Mills," by Charles T. Main, consulting engineer; "Power for Paper Mills," by Joseph Warren, vice-president, S. D. Warren Co.; "Power for Industries Using Relatively Small Amounts of Power," by K. D. Hamilton, George E. Keith Co.

Friday morning, Dec. 11—"Operating Practice," I. E. Moultrop, superintendent of construction, Edison Electric Illuminating Co. of Boston, presiding; "Advantages and Disadvantages of the Use of High Steam Pressures," by Joseph Pope, Stone & Webster, Inc.; "Utilization of Extraction Steam," by Edgar A. Dickinson, General Electric Co., Lynn, Mass.

Friday afternoon, Dec. 11—"Power Problems in Industrial Plant Operation." F. M. Gibson, plant engineer American Sugar Refining Co., presiding; "The Supply of Industrial Power," by W. H. Larkin, Jr., power engineer, general division, U. S. Rubber Co.; Round Table discussion.

Friday evening—Dinner at the new Chamber of Commerce building, with L. E. Moore as toastmaster; E. C. Hultman, vice-chairman, New England Governors Fuel Committee, will speak on the "Coal Situation"; H. R. Linn, American Radiator Co., Chicago, will speak on "Household Heating."

Diesel Engines Ordered for Hollywood, Fla.

Hollywood-by-the-Sea, a new development on the east coast of Florida, eighteen miles north of Miami, is to have the largest privately owned Diesel utility plant in America. This city was laid out in 1923 and now, according to the postal authorities, has a population of 11,000.

Recent orders for Diesel engines have been placed by the Hollywood Electric Light & Water Department, a subsidiary of the Hollywood Land & Water Co., and are evidence of the rapid growth of this development. Early in the summer of 1925 an order was received by the Nordberg Manufacturing Co. for a 1,250-hp. engine direct connected to an 1,100-kva. generator, which is now installed and operating. A second order was recently placed with the same manufacturer for two more Diesel units but of 2,250-hp. each, which are to drive 2,000-kva. generators. These engines will run on cheap, low-grade oil, which assures cheap power for the citizens.

These units are the largest that have been built for service in this country, with the exception of the three 3,750-hp. engines being built for the United States Government to be installed in the Panama Canal.

Society Affairs

The St. Louis Section of the A. I. E. E. will hold a meeting on Dec. 16, at which H. H. Dewey, of the G. E. Co. will speak on "Engineering Research."

The Hartford Section of the A. S. M. E. will have as the subject of its Dec. 10th meeting, "The Manufacture of Genuine Wrought Iron Pipe," by Adolph A. Gathman.

The Boston Sections of the A. S. M. E. and **A. I. E. E.** will hold a buffet supper meeting on Jan. 14 at Lorimer Hall, Tremont Temple, Boston. Vern E. Alden, assistant to the superintendent of the Consolidated Gas, Electric Light & Power Co., Baltimore, will speak on "Latest Design and Practice in Power Plants."

Business Notes

The Girtanner Engineering Corp., 1400 Broadway, New York City, announces the opening of a New England office at 141 Milk St., Boston, Mass., with D. A. Jenkins as district manager in charge.

The Bridgeport Brass Co., Bridgeport, Conn., has recently published "A Historical Sketch of the Bridgeport Brass Company." The history, which covers sixty-five years of manufacturing is illustrated with pictures of the company's early products; the first micrometer, lanterns, fly-fan, lamps, telephone receiver, and other articles which are quaint and full of interest.

The Linde Air Products Co., 30 East 42d St., New York City. At a recent meeting the Board of Directors elected G. W. Mead, formerly president, as chairman of the board. W. F. Barrett, formerly vice-president, was elected to the presidency. R. R. Browning was elected vice-president in charge of sales, and J. A. Rafferty in charge of manufacturing and research.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institute, Washington, D. C. Annual meeting at Kansas City, Dec. 28-Jan. 2.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Petroleum Institute—R. L. Welsh, 250 Park Ave., New York City. Annual meeting at Biltmore Hotel, Los Angeles, Calif., Jan. 19-21.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 20-22.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

Association of Municipal Electric Utilities. S. R. A. Clements, 190 University Ave., Toronto, Canada. Convention at Toronto, Ont., Jan. 27-28.

Engineering Institute of Canada. Richard John Durley, 176 Mansfield St., Montreal, Que. Annual meeting at Toronto, Ont., Jan. 27-29.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Mason City, Iowa, Jan. 27-29.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30.

National Association of Practical Refrigerating Engineers. Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

National Marine Engineers Beneficial Association. George A. Grubb, 313 Machinists Bldg., Washington, D. C. Convention at Washington, D. C., Jan. 18.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Western Association of Electrical Inspectors. W. S. Boyd, 175 West Jackson Blvd., Chicago, Ill. Meeting at Hotel Sherman, Chicago, Ill., Jan. 26-28.

Trade Catalogs

Turbines, Steam—The General Electric Co., Schenectady, N. Y. Bulletin No. GEA-235 describes steam turbines rated at 500, 600 and 750 kw. The general principles and advantages of steam turbines are discussed, and sections and steam path diagrams are included.

Boiler Feed Water—The Griscom-Russell Co., 90 West St., New York City. The fifth edition of a booklet, "Raw Water Distilling Plants for Producing Distilled Boiler Feed Make-up Water," by Joseph Price, has recently been issued. It contains some new heat-balance diagrams used in central station and industrial plants. The booklet may be obtained by applying to the firm.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Nov. 30 1925
Pool 1	New York	$2.75@$3.15
Smokeless	Boston	2.50
Clearfield	Boston	1.85@ 2.10
Somerset	Boston	1.90@ 2.35
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.50@ 1.85
Pittsburgh	Pittsburgh	2.10@ 2.25
Pittsburgh gas slack	Pittsburgh	1.40@ 1.50
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.25@ 2.40
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	2.00
Anthracite, Gross Tons		
Buckwheat No. 1	New York	$2.50@$2.75
Buckwheat No. 1	Philadelphia	2.50@ 3.00
Birdseye	New York	....

FUEL OIL

New York—Dec. 2, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5¼c. per gal., f.o.b., Bayonne, N. J.

St. Louis—Nov. 24, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 5½c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Nov. 27, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6c. per gal.

Dallas—Nov. 28, f.o.b. local refinery; 26@30 deg., $1.58 per bbl.

Philadelphia—Nov. 24, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.65@ $1.71 per bbl.

Boston—Nov. 30, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati—Nov. 24, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6¼c. per gal.; 26@30 deg., 6¼c. per gal.; 30@32 deg., 6¼c. per gal.

Chicago—Nov. 24, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.40.

New Plant Construction

Ala., Anniston—L. Pizitz, 118 19th St., Birmingham, plans the construction of a 12 story office building on Wilmer Ave., here. Estimated cost $500,000. Architect and engineer not selected.

Ala., Birmingham—Alabama Power Co., T. W. Martin, Pres., has been granted permit by the Federal Power Commission to construct a hydro-electric dam and power house, 175,000 hp. ultimate capacity at Lock 18 on the Coosa River. Estimated cost $13,000,000.

Calif., Los Angeles—Rockwell Co., c/o S. H. Dunford, Lincoln Bldg., plans the construction of an 8 story hotel at Sunset Blvd. and Olive Drive. Estimated cost $1,500,000.

Calif., San Jose—Bank of Italy, Powell and Market Sts., San Francisco, will soon award contract for the construction of a 12 story bank and office building at 1st and Clara Sts. here.

Conn., Meriden—Connecticut School for Boys, plans the construction of a boiler house, including laundry, refrigerating equipment, etc. Estimated cost $150,000. W. T. Arnold, 34½ West Main St., is architect.

Fla., Jacksonville Beach—City Comm., N. Finkelstein, Chm., will receive bids until Dec. 10 for the construction of a waterworks system, including Sect. 4 pumping station, Sect. 5 3 centrifugal pumps electric and gasoline drive, etc. George B. Hills Co., Barnett Bldg., Jacksonville, is engineer.

Fla., Tampa—Atlantic Ice & Cold Storage Corp., Washington St. Viaduct, Atlanta, Ga., plans the construction of addition to ice and cold storage plant to increase capacity from 100 to 240 tons daily here. New equipment will be required.

Ga., Savannah—Savannah Oil & Turpentine Co. will soon award contract for the construction of a group of buildings including boiler plant. Estimated cost $75,000. A. S. Carr, is architect and engineer.

Ill., Chicago—Elizabeth Arden, Inc., 675 5th Ave., New York, N. Y., awarded contract for the construction of a 10 story office and stores building at North Michigan Ave. and East Walton Place, here, to Hegeman-Harris Co., Inc., 431 North Michigan Ave. Estimated cost $750,000.

Ill., Chicago — Cornelia Building Corp., T. D. Collins, Pres., Room 616, 310 South Michigan Ave., is having plans prepared for the construction of a 16 story apartment at Sheridan Road and Cornelia Ave. Estimated cost $2,000,000. R. S. DeGoyler & Co., 307 North Michigan Ave., are engineers.

Ill., Chicago — Eitel-Decker Corp., Chicago & North Western Ry. Depot, Canal and Madison Sts., awarded contract for the construction of a 17 story hotel at Cass St. and Delaware Place to McLennan Construction Co., 307 North Michigan Ave.

Ill., Chicago — Estate of Marshall Field, 230 South Clark St., plans the construction of a 21 story stores and office building at Wabash Ave. and Washington St. Estimated cost $4,000,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., are architects.

Ill., Chicago—C. E. Peterson Co., 4911 Wentworth Ave., will receive bids about Jan. 1 for the construction of a factory, including power plant, two 300 hp. boilers, one 300 hp. engine and generator, etc., at 82nd St. and Hoyne Ave. Estimated cost $300,000. F. E. Davidson, 304 South Dearborn St., is architect.

Ill., Danville—Danville Hotel Co. awarded contract for the construction of a 9 story hotel to C. A. Benson, 1743 North California St., Chicago. Estimated cost $1,185,000.

Ill., Decatur—City voted $311,000 bonds for improvements to waterworks system, light plant, etc.

Ky., Murray — City, C. B. Crawford, Purch. Agt. is in the market for a new 300 hp. Diesel engine generator unit for municipal electric plant.

La., Alexandria—Alexandria Ice & Cold Storage Co., E. Harding, Pres., plans the construction of addition to ice plant, 125 tons daily capacity. Estimated cost $150,000. G. B. Mills, 5789 Waterman Ave., St. Louis, Mo., is engineer.

Md., Baltimore — One Hundred University Parkway Apartment Corp., c/o W. G. Nolting, Pres., Keyser Bldg., has had plans prepared for the construction of a 9 story apartment at University Parkway and Canterbury Road. Estimated cost $1,000,000. Wyatt & Nolting, Keyser Bldg., are architects.

Mass., Boston—New England Deaconess Assn., Deaconess Road, plans the construction of a 3 story hospital. Estimated cost $600,000. E. W. Dearing, 103 Pilgrim Road, is architect.

Mass., Lynn — General Electric Co., Western Ave., is having plans prepared for the construction of a turbo generator test base. J. G. Trudinger, c/o owner, is engineer.

Mich., Detroit—Public Lighting Comn., J. S. Foley, Secy., 174 East Atwater St., will receive bids until Dec. 14 for boiler settings and ash handling equipment for municipal power plant at Morrell St.

N. J., Newark—Union Building Co., M. Rachlin, Pres., 815 Union Bldg., is having plans prepared for the construction of a 12 story office building on Academy St. Estimated cost $1,000,000. G. E. Jones, Union Bldg., is architect and engineer.

N. Y., New Rochelle—George Washington Co., is having plans prepared for the construction of a hotel on Locust Ave. Estimated cost $1,500,000. W. M. Mason, 70 East 45th St., New York City, is architect and engineer.

N. Y., New York—A. Brisbane, c/o Evening Journal, William St., awarded contract for the construction of a 15 story hotel at 54th St. and 6th Ave. to Dwight P. Robinson & Co., Inc., 125 East 46th St. Estimated cost $1,500,000.

N. Y., New York—Five Hundred Fifteen West End Avenue Inc., c/o J. M. Felson, 250 West 57th St., Archt. and Engr., is having plans prepared for the construction of a 15 story apartment on West End Ave. Estimated cost $1,000,000.

N. Y., New York—Five Hundred Seventy One Park Avenue Corp., c/o G. F. Pelham, 200 West 72nd St., Archt. and Engr., will build a 15 story apartment at Park Ave. and 63rd St. by day labor. Estimated cost $600,000.

N. Y., New York—H. Phipps Estate, 787 Fifth Ave., plans the construction of a 20 story hotel at 8th Ave. between 49th and 50th St. Estimated cost $8,000,000. Architect not selected.

N. Y., New York—W. Salmon, 17 West 42nd St., plans the construction of an office building at West 43d St. Estimated cost $5,000,000. York & Sawyer, 100 East 42nd St., are architects and engineers.

N. Y., New York—Winfred Realty Corp., c/o H. Roth, 119 West 40th St., Archt., will build a 20 story apartment at Park Ave. and 56th St., by day labor. Estimated cost $1,700,000.

Okla., Collinsville—City voted $23,000 bonds for improvements to waterworks pumping plant. Holway Engineering Co., 505 New Wright Bldg., Tulsa, is engineer.

Okla., Haskell—Oklahoma Natural Gas Co., 117 West 4th St., Tulsa, had preliminary plans prepared for the construction of a natural gas compressor station including five 600 hp. engines and compressors to replace fire loss here. Estimated cost $75,000. A. W. Lee, Tulsa, is engineer. Work will be done by owners forces.

Okla., Marble City—City is having preliminary plans prepared for the construction of a waterworks system including well, tank, pumps, etc. Estimated cost $30,000. Engineer not selected.

Okla., Miami — City, J. J. Rubenstahl, Mayor, is in the market for a 750 hp. Diesel oil engine generator set including exciter and circulating pumps for municipal electric plant.

Okla., Norman—Norman Milling Co. will build extensions to ice plant including storage room, 15 ton ice plant equipment, brine tanks, handling equipment, etc. Estimated cost $50,000. F. Cobb is engineer.

Pa., Allentown—Lehigh Hotel Corp., c/o Kaeppel & Kester, 6th and Linden Sts., awarded contract for the construction of an 8 story hotel to Barras Construction Co., 17th and Locust St. Estimated cost $1,200,000.

Pa., Philadelphia — Continental Hotels Co., 25 West 43rd St., New York, N. Y., awarded contract for the construction of a 20 story hotel at 17th and Locust Sts. here to Barras Construction Corp., 366 Madison Ave. Estimated cost $8,000,000.

Pa., Zelienople—Elliott Nursery Co., Magee Bldg., Pittsburgh, is having plans prepared for the construction of nursery buildings, including boiler plant, etc., here. Estimated cost $50,000. J. H. Phillips, Box 977, Pittsburgh, is architect.

Tenn., Bristol—Cities Service Co., W. A. Hiddleson, Mgr., plans to expend $500,000 for enlargements and improvements to power plant including additional 1700 hp. development.

Tenn., Nashville—Nashville Railway & Light Co., B. C. Edgar, Pres., has appropriated $1,540,000 for improvements to light, power and street car service, including power sub-stations, turbo generator for power plant, etc.

Tex., Colorado—Dillingham & Alexander, Breckenridge, have recently purchased site and plans the construction of an ice and cold storage plant here. Estimated cost $75,000. Engineer not selected.

Tex., Jourdanton—Texas Central Power Co. c/o S. M. Udden, Frost Bldg., San Antonio, has purchased plant from Jourdanton Water & Light Co. and is having surveys made for improvements to power plant.

Tex., Madisonville — Western Public Service Co., Bryant, has acquired ice and electric plants and plans the construction of a refrigeration plant here. Estimated cost $40,000. Company engineers in charge.

Tex., Port Arthur—City will receive bids until Dec. 10 for the construction of a water purification plant including 2100 g.p.m. low pressure and 5400 g.p.m. wash water pumps, two 5 kw. motor generator sets, three 50 kva. 2300/4000 potential transformers, 5 electric motors for pumps, etc. Estimated cost $200,000. J. O. Herpin, City Hall, is engineer. J. P. Logan, mayor.

Tex., Vernon—Vernon Electric & Ice Co., R. N. Smith, Mgr., subsidiary of the Texas Central Power Co., c/o S. M. Udden, Frost Bldg, San Antonio, plans the construction of a 50 ton addition to ice plant also the installation of a 600 hp. oil engine in power house. Estimated cost $160,000. Company engineers in charge.

Tex., Victoria—Victoria Ice & Electric Co., subsidiary of the Central Power & Light Co., is receiving bids for the construction of an electric generating plant, also plans the construction of a power dam across the Guadalupe river near here. Estimated cost $500,000 each. Company engineers in charge.

Wis., Milwaukee—J. T. Ellison, 528 Summit Ave., is having plans prepared for the construction of an 8 or 10 story hotel at Grand Ave. and 11th Sts. Estimated cost $500,000. H. L. Kuehnel, 4625 Woodlawn Court, is architect.

Wis., Wauwatosa—City, A. Hebbring, Supt. of Waterworks Dept., has purchased site and plans the construction of a new pumping station and well at Second Ave. and Wright St. J. E. Lowther, City Hall, is engineer.

Australia, Melbourne—Victorian Government Railways will receive bids until Jan. 20, 1926, for supply and delivery of automatic battery charging equipment.

N. Z., Auckland—Public Works Supplies and Tenders Committee will receive bids until Feb. 16, 1926, for Waikato Power Scheme Sect. 132, two 50 kv. and three 110 kv. oil immersed circuit breakers, one 110 kv. (control pillar pattern) four 110 kv. and one 50 kv. sets airbrake switches, four 50 kv. and eight 110 kv. sets of isolating switches, one 50 kv. and two 110 kv. sets of choke coils, insulators, spares, etc., for Bombay substation.

S. A., Conducta, Ecuador—J. B. Gordon, Ingenio San Carlos, wants catalogs and prices f.o.b. New York, N. Y., U. S. A., for the installation of two 400 hp. horizontal return tubular boilers to include stop, safety and blow-off valves, water columns, gauges, suspended arches and back combustion chamber.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Among the most important fluctuations in prices of materials and supplies during the past month, were advances in structural and boiler rivets at Pittsburgh mills and in cold drawn steel in the Cleveland district. Declines occurred in portland cement, wipers, linseed oil, red and white lead. Cost of power-plant construction is unchanged from the November level.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

Fire Protection			50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket			71c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less		45%
Air—Best grade			
¾-in., per ft.	3-ply $0.37½	4 ply	$0.46
Steam—Discounts from List			
First grade 30-10%	Second grade 40%	Third grade	40-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 50-10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40%
Heavy	30-10%

RAWHIDE LACING { For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ½ in.	$0.90
Asbestos for high-pressure steam, ½ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.70 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	15.00@22.00	19.00	20.00
Colored	10.00@15.50	18.00	17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15½
New York	.17
Cleveland (per thousand)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.99	$1.13	$0.99

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.25	$15.25	$16.75	$16.75
White	15.25	15.25	15.25	15.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, ⅛x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ½-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ¾, ⅞, 1 in. diameter by 2½ in. to 4½ in. sell as follows per 100 lb.:

New York $5.00* Chicago $3.50 Pittsburgh $2.60

Boiler rivets, same sizes:

New York $5.20* Chicago $3.70 Pittsburgh $2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$48@53
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	23@28
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	27@32
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	48@50
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	43@45
Chrome ore crude, 40@ 50%	net ton	19.00@20.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	80.87½
Commercial genuine, intermediate grade	56.00
Anti-friction metal, general service	31.50
No. 4 babitt (f.o.b.)	15.50

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.15	$3.90	$3.60
Flats, squares and hexagons, per 100 lb. base	4.65	4.40	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13
LAP WELD					
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25 50	42 50	27 04
3¼	.....	49 50	30 67
3½	31 50	52 75	33 33
4	38 03	67 00	40 11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3¼ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$36.00 (net)	$ 56.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft.	55%	25%
1,000 to 5,000 ft.	60%	30%
5,000 ft. and over	60-5%	35%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
⅜	$56 50	$61 34	$7 76	$8 83	$4 52	$4 92
½	72 07	78 63	10 21	11 62	6 46	7 03
1	103 31	113 00	15 10	17 21	8 39	9 13
1¼	139 77	152 88	20 51	23 07	11 78	12 75
1½	167 12	182 79	27 34	30 76	14 56	15 75
2	224 85	245 94	50 13	56 40	19 41	21 01
2½	355 50	388 85	82 03	92 28	27 73	30 01
3	464 88	508 50	218 74	246 10	41 59	45 01
3½	585 30	637 74	483 04	543 46	55 46	60 02
4	714 17	776 30	558 23	628 06	69 32	75 02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$23.00
No. 16 cotton reinforced heavy	26.50
No. 18 cotton reinforced light	18.10
No. 16 cotton reinforced light	22.00
No. 18 cotton Canvasite cord	16.75
No. 16 cotton Canvasite cord	19.10
No. 16 super service cord or similar (2 wire)	101.20
No. 14 super service cord or similar (2 wire)	146.40

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100 amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 65%; standard package, 70%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP OR CLEARSITT—

0-30 ampere, standard package (500)	$2.85
0-30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.27	$0.32	120	50	$0.40	$0.45	60
15	.27	.32	120	75	.45	.55	60
25	.27	.32	120	100	.50	.55	24
40	.27	.32	120	150	.65	.70	24
50	.27	.32	120	200	.80	.85	24
60	.32	.37	120	300	1.25	1.35	24
				500	2.00	2.15	12
				750	3.50	3.70	8
				1,000	3.75	3.95	8

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size 2 Pc. Plug—Composition	08½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$7.20	$9.95	$11.80	$18.50
12	10.25	12.98	14.97	24.55
10	13.50	16.90	18.90	31.76
8	18.90	22.90	24.40	42.75
6	.....	.....	35.00	.....
4	.....	.....	47.85	.....
2	.....	.....	68.75	.....
1	.....	.....	89.65	.....
0	.....	.....	120.16	.....
00	.....	.....	142.20	.....
000	.....	.....	169.90	.....
0000	.....	.....	202.67	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	¾ In. Cap Key Each	Keyless Each	Pull Each
$0.36	$0.33	$0.50*	$0.42	$0.39	$0.56*

Less 1-5th standard package	30%
1-5th to standard package	40%
Standard package	45%

* Net.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 35c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 37c. lb., 100 lb. lots	35c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30-5%
$50 list value or over	35%